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A REVIEW OF 20 YEARS' RADIUM TREATMENT OF LIP CANCER AT THE RADIOLOGICAL CLINIC, LUND, SWEDEN[1]

by

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Just as skin diseases in general were the first field of irradiation therapy, it was rather natural that of all forms of tumour skin tumours should be the very first to be subjected to this new method of treatment.

In Sweden, STENBERG and SJÖGREN as far back as 1900 treated several cases of skin cancer by roentgen rays with good results. FORSSELL continued and developed the radiotherapy of malignant tumours, and with the foundation of Radiumhemmet in 1910 this method of treatment was still further advanced.

On account of the favourable results obtained in irradiation treatment of skin cancer, the treatment was soon extended to the clinically, and to some extent histologically, closely related lip cancer. Like all skin cancers, especially those of the face, lip cancer is suitable for irradiation therapy, also from that point of view that in most cases the tumours heal without cicatrization or permanent defects. Even large infiltrating skin and lip tumours are often observed to reform without leaving a trace.

Already during the first years of the activity of Radiumhemmet the material of lip cancer increased to such an extent that during the period 1910—1917 at that clinic alone 86 cases, of which 66 were cancers on the lower lip, were radiologically treated. In 1918 FORSSELL gave a first report of the results of the treatment, and in 1924 he again published an account of the healing results after an observation period of at least 5 years. In his report FORSSELL differentiates superficial and infiltrating tumours of the lower lip; of the former type 90 per cent had healed after

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5 years, but only 34 per cent of the infiltrating type. More than half he latter, however, were inoperable from the beginning. The figure for he healed infiltrating but technically operable tumours of the lower lip was 75 per cent. and for all operable cases 86 per cent.

The good results obtained at Radiumhemmet led EDLING to introduce radium treatment of lip cancer very shortly afterwards at the Lund Clinic. Here, too, this method of treatment advanced rapidly so that during he period 1914—1934 the total material of *cancer of the lower lip* alone at present amounts to 269 cases.

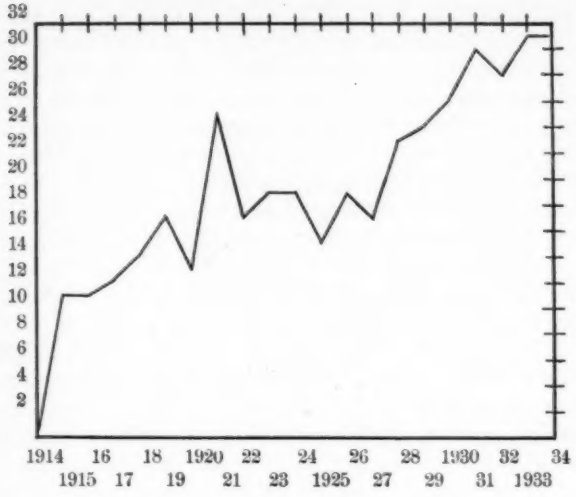
In the first years only a few isolated cases were treated, which were exclusively cases of recurrence and inoperable cases. But especially after FORSSELL had published the report of his first results in 1918, the number of treated cases of lip cancer also in Lund began to show an evident increase. Besides, an increasing number of early cases of lip cancer were continually being sent to the clinic for treatment, according as the belief in the suitability of radiotherapy in lip tumours began to gain ground. And since 1928, when the Radiological Clinic at Lund became a central institution for cancer treatment, radiotherapy has become the principal method of treatment for lip cancers at Lund Hospital.

In order to obtain a survey of the distribution of the number of cases in different years we refer the reader to the following curve (page 3), from which can be seen the rise in frequency in the period of time mentioned:

Year	Number of cases	Year	Number of cases	Year	Number of cases
1914	1	1921	15	1928	19
1915	1	1922	13	1929	15
1916	4	1923	17	1930	18
1917	2	1924	13	1931	20
1918	6	1925	13	1932	21
1919	8	1926	15	1933	21
1920	9	1927	7	1934	31

Of the 269 cases recorded, 4 have been excluded from this report. In 3 of these 4 cases the treatment was discontinued at the very outset by the patients themselves and in the remaining case it has not been possible to trace and control the patient. All the remaining 265 cases have been followed up and after-examined. All cases showed on admission clinically sure signs of cancer. All cases in which the diagnosis of cancer was made with a certain amount of hesitation, as for instance (cancer?), or when the case has been denoted as chronic ulcer, have not been included in this material.

The *distribution of the lip tumours* in the two sexes shows the familiar relation that by far the greatest number of cases of cancer of the low-



lip occurs in males. Of the 265 patients, 23 were females = 8.7 per cent., and 242 males = 91.3 per cent. As comparison we may mention NYSTRÖM's statistical record, where of 344 cases of lip cancer, 289, or 84 per cent., were males and 55, or 16 per cent., were females.

The age distribution will be seen from the following figures: (In one case the age of the patient was not recorded.)

20—30 years	. . . . .	2 cases	
30—40 »	. . . . .	11 »	
40—50 »	. . . . .	21 »	
50—60 »	. . . . .	51 »	
60—70 »	. . . . .	84 »	179
70—80 »	. . . . .	72 »	
over 80 »	. . . . .	23 »	

From the above table it will be seen that 179 patients, 67.5 per cent., were over 60 years of age, which shows that lip cancer to an exceptionally high degree is to be regarded as a form of cancer occurring in advanced age. Owing to the high incidence of lip cancer at advanced ages it must be taken into account that a large number of the patients die from diseases incident to old age shortly after the treatment. These cases thus form a considerable percentage of those causes of death designated as intercurrent diseases.

In many quarters, and not least in Sweden, it has been the rule in compiling statistics of cancer to include the patients who die from inter-

current diseases among those who have died from cancer. But in this material, where such a large number of the patients already at the onset of the disease were above 60 years of age, there is no reason to employ that method of computation. If we examine closely the causes of death recorded for our patients who died from intercurrent diseases we shall see that these causes are to a great extent pronounced old age diseases such as »stroke», »weak heart», »decrepitude», etc. In the majority of these cases the records also show that at the time of death the patient was free from symptoms of the lip cancer. In this report I have therefore referred all those who died from an intercurrent disease to a special group.

When it comes to the question of determining the *duration of the disease* before the treatment was commenced, we are faced with certain difficulties owing to the fact that the information supplied by the patients is often indefinite and vague. And this in spite of the fact that owing to its location the cancer can be observed easily and at an early stage by the patients themselves. But it is striking how indifferent patients are in many cases to affections not associated with pain. In this case the patients are for the most part elderly persons with an obtuse power of observation.

The data concerning the duration of the disease must therefore be taken with reservation, and I do not venture to give any exact figures. Some idea of the duration of the disease may be gathered, however, from the following tabulation:

1—3 mths	57	cases
3—6 »	25	»
6 mths—1 yr.	72	»
1 yr —2 yrs	40	»
2 yrs —3 »	16	»
3 » —4 »	3	»
4 » —5 »	5	»
over 5 »	8	»

It is worthy of note that several of these figures indicate that the tumour had been present for quite a long time before the patient had found any reason to consult a doctor. In several cases, however, the cancer must have developed on the basis of a local, non-malignant hyperplasia, such as an acanthoid wart or the like. In 112 cases the disease had a history of $^1/_2$—2 years and in 32 cases of over 2 years. From these figures it can be assumed that a considerable number of the cases on admission were in an advanced stage, possibly with glandular metastases. This will appear more clearly from the information given below concerning the size and infiltration of the tumours and the extent of glandular metastases.

The Macroscopic Appearance of Lip Tumours

In both skin tumours of the face and in the lip cancer FORSSELL has, on the basis of the macroscopic appearance of the tumours, distinguished 2 main groups: 1. *Superficial*, by which he means such tumours as only involve the skin, the mucosa and the subcutaneous tissue, and 2. *Infiltrating* tumours, which penetrate also the subcutis and are attended by a certain degree of fixation of the tumour.

I have tried to follow this system of classification also in respect to the L[illegible]nd material and thus define as 1. *superficial* tumours those which are confined to the skin or mucosa of the lip and the underlying submucosa or submucous tissue, and 2. *infiltrating* tumours those which infiltrate the entire thickness of the lip, often involving the bucca and even the gingiva, occasionally also the skin of the chin or cheeks. The superficial tumours may sometimes involve a small area of the bucca or adjacent parts of the skin, but this is, however, rather unusual at this stage.

Among the *superficial tumours* I have been able to distinguish 3 different clinical types: a) The most common type, about 73 per cent. of the cases, is the superficial ulceration, the edges of which are nearly always elevated; later there frequently arises a lamellar infiltration, hard as cartilage, during the ulceration; b) A type which is also comparatively common (in 21 per cent., of the cases) is the exophytical, papillomatous tumour, which is as a rule sharply demarcated from the normal tissue; c) Finally, in a small number of cases (6 per cent.) the lip cancer is in the form of a submucously growing infiltrate, over which the mucous membrane of the lip retains its normal appearance.

In regard to the *infiltrating tumours* it is possible in this material to distinguish all stages, from limited tumours, which have nevertheless penetrated the entire lip from skin to mucosa, to the diffuse, fixed, ulcerating tumour infiltrates, which sometimes grow out through the skin, bucca and gingiva, and sometimes may penetrate and infiltrate the lower jaw-bone.

Although superficial lip tumours, already on the patient's admission to hospital, may occasionally exhibit evident *metastases* to the regionary lymphatic glands, this is much more common in the case of the infiltrating forms. Generally speaking, cancer of the lip is characterized by a relatively slow rate of growth, and KREYBERG points out that they metastasize later than tumours of the mouth cavity, which implies that this form of tumour has a relatively good prognosis.

The localization of the regionary *lymphatic glandular metastases* in cancers of the lower lip is determined by the location of the tumour on the lip. Thus a tumour in the midline of the lip metastasizes via the lymphatics down into the lymphatic glands in the fossa submentalis,

while tumours situated in the lateral part of the lip generally d velop metastases in the lymphatic glands in either of the submaxillary ossae. In the latter case the gland first affected will as a rule be one si uated high up under the lower jaw at the external maxillary artery (KREY ERG). The process remains localized for a comparatively long time t this gland. Attention should be called to the important fact that in not a few cases the patient, on admission, does not exhibit any palpable gland but that metastases nevertheless develop as late as six month after the treatment.

The Histological Picture

As known, in practically all cases cancer of the lower lip is in its histological structure a spinocellular cancer with a differentiating of corneous pearls. The occurrence of basal cell cancer is exceedingly rare on the lower lip. In one case in our material the patho-anatomical report was basal cell cancer, but a control examination is unfortunately impossible because the microscopical preparation has been destroyed.

In the Lund material histological examinations of the lip tumours were unfortunately made in only 90 cases. Owing to an insufficient staff excisions were made in the first years in only exceptional, more doubtful cases, but since 1932 biopsy specimens have been consistently taken in all cases. Of the 90 lip tumours examined microscopically, 89 showed a spicocellular structure, basal cell cancer was found in only one case, that mentioned above.

Treatment

The most important element affecting the results of radiological treatment is of course the occurrence of *lymphatic glandular metastases*, but even the size and the extent of the *primary tumour* and the degree of infiltration are of great importance from the point of view of prognosis and therapeutic treatment. It seems to me that this historical survey will gain in clarity if the therapy of the primary tumours and of the glandular metastases are dealt with separately.

I. Primary Tumour

We shall first consider the treatment of the primary tumour and in doing so follow the principles for their classification employed by LACASSAGNE in his work on tumours of the lower lip.

It is probably owing to the French technical procedure, which implies an estimation of the dose in »millicuries détruites» in proportion to the size of the tumour, that LACASSAGNE divided superficial tumours into 2 stages and infiltrating tumours also into 2 stages. As this classification

seems to afford certain advantages for judging the results of the treatment, I have also in the present material distinguished 4 stages.

To *Stage I* LACASSAGNE refers all superficial tumours measuring less than 2 cm. in their greatest diameter; in our material 88 cases (39 per cent.) belong to this group. *Stage II* comprises tumours, the greatest diameter of which is more than 2 cm., but the tumour does not extend beyond the area of the lip. The greatest number of cases in our material, 116 or 51 per cent., belongs to this group. Those tumours belonging to Stage III, according to LACASSAGNE, measure more than 2 cm. in their greatest diameter but they also involve the buccal surface, the chin or the upper lip. 22 cases, or 10 per cent., in the Lund material belong to this group. Finally, LACASSAGNE has a stage IV, where the tumour also involves the lower jaw bone and destroys it. In our material only one or two of the recurrences after operation can be referred, at the beginning of the treatment, to this group.

The Technique of the Treatment

In a few of the earliest cases the primary tumour was treated at Lund with a combination of roentgen and radium, but otherwise radium treatment has been used exclusively. Up to the end of 1928 this radium treatment consisted of what is now called in FORSSELL's nomenclature brachyradium treatment, i. e. the radium tubes were applied with varying filtration to the surface of the tumour at short distances apart. At first great difficulties were encountered in satisfactorily fixing the radium tubes. For that reason, in Lund the radium tubes were enclosed in lead containers of varying sizes and fixed to the lip tumour by means of adhesive plaster; in other clinics other methods of fixing the radium tubes were employed. A great advance in the technique was made, however, when EDLING in 1915 introduced Kerr's plastic compound mass for the application and fixation of radium tubes. The progress made in the technique in the next few years was described by EDLING in his dissertation for the degree of M. D., »Studien über Applikationsmethoden in der Radiumtherapie» (1918) and by BERVEN (1917).

This surface radium treatment, which in its improved form was the only method of treatment used during the period 1918—1928, was divided into two sittings, each occupying a period of 15—20 hours, as a rule with an interval of one day between the two sittings.

The technique was briefly as follows: The radium contained in gold-platinum tubes of 5—10 mg. and with a lead equivalent of 1 mm. were fixed by means of plastic compound to the lower teeth and the lip. By means of another layer of compound, 4—5 mm. in thickness, on the underside of the lead filter a firm fixation of the entire applicator against the teeth was obtained and a suitable irradiation distance.

The disadvantage of this otherwise excellent method of treatment was that it was very troublesome and tiring to the patients, who were also compelled to remain at the hospital during the entire course of the treatment. It also called for a rather high degree of technical skill in the clinician, and moreover the application took a considerable time.

In 1929 a change was therefore made at the Lund Clinic in the technique of treating lip tumours, intubation of radium needles being introduced as the principial method of treatment.

Other clinics had already for a considerable time past been employing intratumoral treatment with tubes or needles of various kinds. According to EDLING, intratumoral irradiation seems to have been first introduced by STREBEL, but was further developed by the American workers ABBE and MORTON. The latter used as radium containers glass or aluminium tubes enclosed in celluloid capsules, which were inserted in the incision wound. This method was improved by the Frenchman, DOMINICI, who substituted the old glass or aluminium tubes for gold or platinum tubes. Treatment by intratumoral irradiation was introduced quite early at Radiumhemmet and from the beginning of 1926 the intubation method was employed there in lip cancer.

In the first years needles of about 4 mg. were used in Lund, but in 1931 they were replaced by needles of 3 and 6 mg. and in 1932 by 5 and 10 mg. needles. The wall of the 3 and 6 mg. needles is made of 0.3 platinum with a filtration equivalent to 0.5 mm. lead and enclosing 1 or 2 cells containing the active radium substance. The 5 and 10 mg. needles are made in the form of double tubes with a wall thickness of together 0.5 mm. Pt equivalent to a filtration of 1 mm. lead. The 3 mg. needles are 20 mm. in length with an active portion of 10 mm. The length of the 6 mg. needles is 30 mm. with an active portion of 21 mm., that of the 5 mg. needles 11 mm. and of the 10 mg. needles 15 mm. with an active portion of 8—9 mm.

The treatment is performed as follows: After local anaesthetization with 1 % novocaine a small incision is made in the lip and the needle is inserted by means of a needle holder in the shape of a pair of forceps, the shanks of which are grooved exactly to fit the needle. The needles are embedded in the tumour in such a manner that the irradiation will be as homogeneous as possible and the distance between the centres of the needles is measured at about 7 mm.

The 3 and 6 mg. needles require a treatment period of as a rule 12—15 hours, the 5 mg. needles a period of about 10 hours. The 10 mg. needles, on the other hand, require only a period of 3—4 hours.

The older types of 4 mg. needles as well as those of 3 and 6 mg. were soon found, however, to be unsuitable for treatment of lip tumours. As mentioned above, the radium concentration in these needles was such

that a long period of treatment was necessary, which in turn gave rise to an excessive local irradiation of the tissues. On that account there often arose after the treatment a chronic hard infiltrate or a local necrosis at the site of the tumour, which was difficult to distinguish from a recurrence or a metastatic node. On the other hand, actual recurrences occurred not infrequently, due to the unsuitable radium concentration, the margins of the tumour not receiving a sufficiently intensive treatment. As a final issue of the treatment with these needles an atrophy and shrinking of the lip was frequently observed in healed cases.

Neither did the 5 mg. needles prove satisfactory in the treatment of lip cancer, being too short for large tumours, and good results were first obtained when we began to use the 10 mg. needles, which have a suitable radium concentration. At present these needles are used almost exclusively with an application period of 3—4 hours.

An advantage of the intubation method is that it can be performed quickly and with but little discomfort to the patient and in addition it affords the great advantage that treatment can be carried out at a policlinic.

After about a week there occurs a radium reaction with an epidermitis, which varies in intensity according to the quantity of radium employed and the duration of the period of treatment. In uncomplicated cases there appears only an erythema and a desquamation of the outer layers of tissue; this reaction reaches its maximum after about 3 weeks and then disappears rapidly with a simultaneous resorption of the tumour.

Parallel with the reaction it is possible in favourable cases to note how the tumour decreases, is destroyed and gradually completely resorbed while at the same time an epithelization of the ulcerated surface is taking place. Finally there remains only a slight oedema, which also gradually disappears. Occasionally this oedema may be rather solid and has the character of an infiltrate, but that, too, will be resorbed, although more slowly. In intubation treatment the punctures made by the radium needles are also smoothed out and the cosmetic result will be excellent.

In a more intensive irradiation there appears at the same time as the resorption of the tumour a moistening epidermitis with a soreness and swelling of the lip, a condition which may occasionally be rather troublesome to the patient. As a rule, however, the reaction usually subsides after another 14 days, after which healing is rapidly completed.

Possible cancer residues or recurrences, which are exceedingly rare with our present technique, are treated with a further intubation; only in a few refractory, recurrent cases was it necessary to resort to a coagulation or electro-excision of the recurrence. In only one case in our material has it been necessary to make a wedge excision of a recurrence.

Thus since 1929 the intubation method is employed in all cases of superficial tumours and those infiltrating tumours which are easily movable and which have not progressed to a great extent outside the area of the lip.

At about the same time as the intubation method was introduced, a change was made in technique of the treatment of large fixed primary tumours. Up till then these tumours had also been treated with radium protheses of a plastic compound, but as the results of the treatment were frequently found to be unsatisfactory teleradium treatment was now introduced in these advanced cases.

Teleradium treatment, which implies a deep treatment by distant irradiation with very large quantities of radium, was performed during the period 1928—1931 by means of a radium »gun» constructed by EDLING, the radium being placed at a distance of 5 cm. from the surface of the skin. At present the »gun» constructed by SIEVERT is being used. In this method, too, the radium is placed at a distance of 5 cm. from the surface of the skin. The field of irradiation is circular and has a diameter of 5 cm. The quantity of radium employed, which varied in 1929 according to the daily quantity of radium available — the supply of radium at the clinic at that time was very small — was from March 1930, thanks to a deposit of radium from »King Gustaf V's Jubilee Fund», kept invariably at 1220 mg. and has since been increased to 2 gr. The treatment is applied in one or more fields to the tumour for a period of 1—2 hours daily. In those cases where one can be satisfied with a single field on the tumour, about 20,000 mg. hrs. Ra are given, but in those cases where the irradiation must be spread over several fields, 12,000—14,000 mg. hrs. are given to each field.

The size of the total dose and the degree of fractioning determine in teleradium treatment the appearance and intensity of the radium reaction. Here, as in brachyradium treatment, one can observe an erythema and a moistening epidermitis with an epithelial desquamation and a simultaneous cleansing and reduction of the tumour. The reaction is considerably more pronounced in teleradium treatment and is nearly always accompanied by similar changes also in the mucous membrane of the mouth cavity and the tongue. For a short period this reaction may be rather troublesome to the patient, but as a rule it disappears 3 weeks after reaching its maximum without leaving any discomfort for any length of time.

Of the primary tumours, 85 were treated with intubation, 7 with teleradium and the remainder with radium protheses.

Results of Treatment in Primary Tumour

The following analysis of the results of treatment refers only to primary tumours directly treated with radium. I have separated from the

material 39 post-operative recurrences, which will be dealt with separately in a special connection.

The treatment results will be seen from Table 1. This table shows the results 3 and 5 years after the termination of the treatment. Thus, of 202 cases observed for at least 3 years 159 or *78.7 per cent.* were entirely free from symptoms. If we also include the 19 cases which died from intercurrent disease, the total will amount to 178 cases, or *88.1 per cent.*

Table I

Primary Tumours

Stage	After 3 years									After 5 years								
	Total number	Free from symptoms		Died from intercurrent disease		Total symptom-free and died from inter. dis.		Died in progress of disease		Total number	Free from symptoms		Died from intercurrent disease		Total symptom-free and died from inter. dis.		Died in progress of disease	
		No.	%	No.	%	No.	%	No.	%		No.	%	No.	%	No.	%	No.	%
I	80	69	86.3	9	11.2	78	97.5	2	2.5	68	49	72.0	17	25.0	66	97.2	2	2.8
II	98	80	81.6	8	8.2	88	89.8	10	10.2	84	55	65.5	16	19.5	71	84.4	13	15.6
III	24	10	41.7	2	8.3	12	50.0	12	50.0	20	6	30.0	2	10.0	8	40.0	12	60.0
	202	159	78.7	19	9.4	178	88.1	24	11.9	172	110	63.9	35	20.4	145	84.3	27	15.7

If we separate the inoperable primary tumours, Stage III, and consider the figures for Stages I and II, i. e. the operable cases, the result will be 86.3 per cent. for Stage I, and together with those cases who died from intercurrent disease = 97.5 per cent. The figures for Stage II will be 81.6 and 89.8 per cent. respectively.

In Table 1 will also be found the results of the 172 cases observed for at least 5 years. Of these, 110 are free from symptoms (63.9 %). If we add the 35 cases which have died from intercurrent diseases, the figure will be 84.3 per cent. The corresponding figures for Stage I are 72 and 97.2 per cent. respectively and for Stage II 65.5 and 84.4 per cent. respectively.

The large number of patients which died from intercurrent diseases during the 5-year period were practically all at an advanced age already at the onset of the disease. As already mentioned above, most of these intercurrent diseases were really affections of old age. Other intercurrent diseases were pneumonia, heart disease, etc.

II. Metastases to Lymph-Nodes

From what has been said above it appears that the indications for radium treatment of a primary tumour are exceedingly well-defined, and that the result of the treatment from a clinical point of view must be regarded as quite satisfactory.

The question of the treatment of the regional lymph-nodes and the technical application of this treatment is a much more complicated matter. In each separate case it is first necessary to ascertain whether there are any sure metastatic nodes. But the clinical discovery of metastases to the lymph-nodes always presents a certain amount of difficulty. Then the question arises as to what steps should be taken if there is any doubt as to the character of the nodes present. Even in those cases in which there are quite surely metastatic nodes, different treatment methods may be discussed from a technical point of view. No definite solution of the problem concerning the treatment of these metastases have been arrived at so far.

However, in order to get a survey of the treatment of metastatic nodes and the results obtained in that treatment, I shall at first leave the primary tumours out of account. For the sake of clarity these metastases may also be classified, according to BERVEN's system, into 3 groups, although it must be borne in mind that the boundary-lines between these groups are not always easy to draw. Much depends on the diagnostic skill and clinical experience of the examining physician. And in a number of cases it is impossible without a histological examination to determine whether a node is really infiltrated. A case may sometimes be wrongly judged in so far that metastases may occur several months later, especially in primary tumours of long-standing. I have, however, tried to make this classification with all reservations for possible mistakes.

Stage I: No palpable nodes in the regionary areas or only soft, movable nodes without the character of tumorous metastases. In our material 159 cases belong to this group.

Stage II: Palpable, firm or hard nodes of a suspicious or certain cancerous character, all operable (60 cases).

Stage III: comprises fixed metastases, where the cancer had penetrated the capsule of the nodes and infiltrated into the surrounding tissue. Only 6 cases belong to this group.

Treatment Procedure.

The technique has also varied here considerably during the 20-year period under consideration.

If we examine the treatment procedure for regional nodes in each stage we shall find that, prior to 1931, in *Stage I* prophylactic treatment

of the regionary nodes was given only by way of exception. After 1931, however, such treatment was consistently carried out, the dose as a rule being about $^2/_3$ S. E. D. with $^1/_2$ Cu 1 Al. filter with a tension of 165 kilovolts in a large field to both submaxillary fossae and the adjacent parts of the neck.

In *Stage II* the regional nodes were treated with roentgen rays in the above-mentioned dose, a number of cases also with teleradium. Before 1929, however, owing to the scanty supply of radium, radium protheses at a distance of 3 cm. and in a dose of 3—4—5,000 mg. hrs. were employed instead of teleradium at a distance of 5 cm. In this method a certain fractioning is done by distributing the treatment over a period of 2—3 days with an interval of 1—2 days.

After 1929, on the introduction of the treatment of the regionary nodes with teleradium at a distance of 5 cm., the following combined radiological-surgical treatment has been developed, and is at present employed in various modifications. The procedure is the following: 1. Treatment of the regionary glands with teleradium in one or more fields to each region in a dose of 10—17,000 mg. hrs. per field for a period of 4—8 days. In a single field to one node at least 20,000 is given. 2. When the reaction has subsided, remaining nodes, if any, are extirpated, sometimes with a simultaneous application of radium in the surgical wound (5—10 mg. tubes in a dose of 12—1500 mg. hrs. for 20 hours). 3. Postoperative treatment with teleradium as before extirpation, or more usually with roentgen rays in a dose of 1—$1^1/_2$ S. E. D. with $^1/_2$ Cu 1 Al.

In *Stage III*, prior to 1929, prothetic treatment was given to the nodes in the above-mentioned doses, at present teleradium treatment is chiefly given in several fields to the glandular regions with a dose of 10—18,000 mg hrs. in each field. In only 3 cases has a combination of radium and roentgen treatment been used. In this stage surgical therapy is not possible.

Results of Treatment.

Table II (page 14) gives the results of the treatment after a period of observation of 3 and 5 years. In Stage I there are after at least 3 years 118 patients, or 84.3 per cent., free from symptoms. If we add the 13 patients who died of intercurrent disease the figure will be 93.6 per cent. The remaining 9 patients died from cancer. The corresponding figures for Stage II are 73.2 and 82.1 per cent. respectively, but 10 patients died from cancer. In Stage III all the patients died, 5 of them from cancer and 1 from intercurrent disease.

The table also shows the figures after a period of observation of 5 years. Thus in Stage I there are 68.9 % (91.8 %) free from symptoms, and in Stage II, 59.1 % (72.7 %).

Table II

Metastatic Nodes

Stages	After 3 years									After 5 years							
	No.	Free from symptoms		Died from intercurrent disease		Total symptom-free and died from inter. dis.		Died in progress of disease		No.	Free from symptoms		Died from intercurrent disease		Total symptom-free and died from inter. dis.		Died in progress of disease	
		No.	%	No.	%	No.	%	No.	%		No.	%	No.	%	No.	%	No.	%
I	140	118	84.3	13	9.3	131	93.6	9	6.4	122	84	68.9	28	22.9	112	91.8	10	8.2
II	56	41	73.2	5	8.9	46	82.1	10	17.9	44	26	59.1	6	13.6	32	72.7	12	25.6
III	6	—	—	1	16.7	1	16.7	5	83.3	6	—	—	1	16.7	1	16.7	5	83.3
	202	159	78.7	19	9.4	178	88.1	24	11.9	172	110	64.0	35	20.3	145	84.3	27	15.7

I shall pass on to a closer analysis of the technique and the results of the treatment of the regionary nodes in the different stages in order to be able, if possible, to draw some further conclusions.

Of the 159 cases referred to Stage I the glandular regions were not treated in 120 cases. If these cases are followed later on it will be found that 66 are still living free from symptoms, 48 have died of intercurrent disease and, finally, 2 have died in the progress of their lip cancer. In the remaining 4 cases metastatic nodes gradually developed, which were treated with roentgen rays 1—1½ S. E. D. ½ Cu 1 Al or radium in the manner mentioned above. In 3 cases the irradiation was accompanied by an extirpation of the node. A histological examination of the excised nodes showed the presence of cancer in two cases, in the third case, on the contrary, no signs of malignancy were found. All 4 cases are at present free from symptoms, the 2 cancer cases 6 and 12 years respectively after the treatment, the third case 5 years after the treatment.

The remaining 39 cases belonging to Stage I were all given treatment of the regionary lymph-nodes from the beginning, the dose being ½ S. E. D. with ½ Cu 1 Al-filter to each submaxillary fossa.

Of these 39 cases 25 were afterwards free from symptoms; 4 died from intercurrent disease and 1 due to his lip tumour. In 2 cases metastatic nodes gradually developed, which were treated with teleradium and extirpated, the patients being subsequently free from symptoms for 1½ and 1 year respectively. Histological examination showed cancer in both cases. No mention is made in the patho-anatomical report as to the effect of the radium treatment on the cancer, and unfortunately no control is at present possible. Metastatic nodes developed also in the 7 remaining cases, which were likewise treated with teleradium and ext-

pated, the histological diagnosis being cancer, but the patients have since died from the effects of their metastases 1—3½ years after the treatment.

The conclusions that may be drawn from these results of the treatment with respect to prophylactic treatment of the regionary lymphnodes may be formulated as follows:

In the 120 cases in which expectant treatment was given, 2 patients have died, it is true, due to their lip cancer, but among the other 118 cases nodes have since developed in only 4 patients, and of these cancer was found in the nodes in only 2 cases, i. e. in 3.3 per cent. In the other 114 cases no subsequent metastatic nodes have been discerned. The clinical examination of the glandular regions in this stage has thus shown itself to be on the whole reliable.

Summarizingly it may thus be considered justified in employing an expectant treatment in those cases in which no nodes are palpable, and in which the primary tumour is small and superficial, *but only on condition that there are opportunities of carrying out frequent and careful re-examinations of the patient.* In 4 cases metastatic nodes nevertheless developed later, in all cases within a year after the treatment of the primary tumour. In 2 of these cases there was an extensive ulcerating primary tumour, involving the whole of the lip, while in the other 2 cases the primary tumour belonged to Stage I. Therefore since 1931, in order to be on the safe side, all patients are given prophylactic treatment of the regional lymphnodes.

Of the 39 cases treated prophylactically metastatic nodes developed in 9. In 6 of these cases the primary tumour belonged to Stage II and in 3 cases to Stage I. This lower percentage, 23.3 per cent., as compared with the preceding group, is at first sight rather surprising, as the reverse was to be expected. However, if the hospital records are examined a little more closely it will be found that of the 139 cases referred to Stage I, 9 had palpable nodes but which are entered in the records as not suspected cases of tumour. In 5 of these cases sure cancerous nodes have since developed. Thus a number of these cases should rightly be classed as belonging to Stage II, which partly explains the discrepancy.

Treatment of the regionary glands was not given in 17 of the 61 cases referred to Stage II, the nodes present being evidently not regarded as infiltrated by the cancer. Of these 17 cases, 10 became free from symptoms, 6 died of intercurrent disease, and only 1 patient has died owing to the spread of the cancer.

In 33 cases the glandular regions were treated with roentgen or radium and in one or two cases with a combination of both. Of these patients 19 are free from symptoms, 7 have died from intercurrent disease and 7 from cancer.

Finally, in 11 cases a combined radiological and surgical therapy was given along the lines already described, i. e. the radiologically treated nodes were extirpated, followed usually by post-operative radium therapy. Of these 11 cases 6 became free from symptoms, 1 has died of intercurrent disease and 4 from cancer. Cancer was found in the extirpated nodes in 8 cases, while 3 showed no evidence of tumour.

In spite of the fact that the above figures show that successful results were obtained although no prophylactic treatment was given in 16 of the 17 cases, an active therapy must nevertheless be considered necessary in this stage. Of the 11 cases in which the nodes were extirpated, in 8 of them the nodes were found to be infiltrated, and of all the 61 cases 12 have died from cancer.

All the 6 cases belonging to Stage III were in a very advanced stage of the disease. They had besides a large primary tumour also large, hard, fixed glandular masses, which were treated with heavy doses of roentgen rays as well as radium. In all cases an improvement and a regression of the tumour masses was noted at first, but before long a progression again occurred and the patients died within $^1/_2$—$1^1/_2$ years after the treatment was commenced. One of the patients, however, died from an intercurrent disease, and at the time of death a regression of the tumour was discernible.

Summary of the results of treatment

After this analysis of the results of treatment, in which I have discussed the primary tumour and the metastases to the lymph-nodes separately, it may be of practical interest to examine the results of treatment in the separate cases, regarded as a clinical unit.

In order to obtain a criterion for the clinical gravity of the cases I have attempted to determine the *degree of operability* of the separate cases. It is, however, rather difficult in a re-investigation of this kind to determine for certain whether, for instance, a lip tumour involving a large portion of the bucca is technically operable. I have therefore drawn the boundary lines for the inoperable group within very narrow limits and have referred to this group only those cases which had for certain immovably fixed metastatic nodes, thus mostly corresponding to Stage III above, and a few cases with large, fixed lip cancers, which had infiltrated into large areas of the bucca and involved the gingiva.

Another 15 cases, which were referred above to Stage III, in view of the primary tumour, have been classified among the operable group, for they can be considered to be technically operable, although extensive surgical interference together with supporting plastic measures would have been necessary.

Table III shows the results of treatment of the cases observed for at least 3 and 5 years respectively. Of the 202 cases *observed for at least*

Table III

Comparative Results in Operable and Inoperable Cases

	After 3 years									After 5 years								
	No.	Free from symptoms		Died from intercurrent disease		Total symptom-free and died from inter. dis.		Died in progress of diseases		No.	Free from symptoms		Died from intercurrent disease		Total symptom-free and died from inter. dis.		Died in progress of diseases	
		No.	%	No.	%	No.	%	No.	%		No.	%	No.	%	No.	%	No.	%
Operable	181	153	84.5	17	9.4	170	93.9	11	6.1	152	105	69.1	33	21.7	138	90.8	14	9.2
Inoperable	21	6	28.6	2	9.5	8	38.1	13	61.9	20	5	25.0	2	10.0	7	35.0	13	65.0
	202	159	78.7	19	9.4	178	88.1	24	11.9	172	110	63.9	35	20.4	145	84.3	27	15.7

3 years, 159 or 78.7 per cent. are still alive and entirely free from symptoms. If these are added to the 19 which have died from intercurrent disease, the healing figure will then be 88.1 per cent. During the 3-year period 24 patients (11.9 %) have died from cancer.

If we now examine operable and inoperable cases seaparately, we shall find that 153, or 84.5 %, of the 181 *operable* cases are still living free from symptoms 3 years after treatment, to which should be added the 17 cases which have died of intercurrent disease = 93.9 per cent. Of the 11 patients, who have died of cancer, 4 died within less than 1 year.

Of the 21 *inoperable* cases, 6, or 28.6 per cent., were free from symptoms after 3 years; together with the 2 patients who died of intercurrent disease the figure will be 38.1 per cent. 13 (61.9 %) patients died of cancer, 5 of them within 1 year and the remaining 8 within 2 years.

Table III also shows the results of treatment *after an observation period of at least 5 years*. Of the 172 cases, 110 remain free from symptoms = 63.9 per cent., and if the 35 patients who have died from intercurrent disease are added, the figure will be 84.3 per cent.

The corresponding figures for the 152 *operable* cases will be 69.1 and 90.8 per cent. respectively and for the *inoperable* 25 and 35 per cent. In this time interval altogether 27 patients have died of cancer, while another 3 of the operable cases have now died from the disease. These 3 had recurrences partly locally, partly metastatic nodes, 1 case after $3^1/_2$ years, 2 after a period of fully 4 years free from symptoms.

III. Operative Recurrences, later treated radiologically

As already mentioned, our material contains 39 operative recurrences, which did not come to radiological treatment until one or more years

after the operation. Thus all these cases presented from the beginning recurrence *in loco* or in the regionary glands, and most of them were in an advanced stage.

For the sake of clarity I have also here found it to be appropriate to try to divide these cases into groups. In *Group I* I have classed only 3 cases, all of which had minor recurrences *in loco*, at most 2 cm. in diameter, but no palpable metastases in the regionary glands.

Group II comprises large recurrences *in loco*, which were nevertheless confined to the lip, with or without palpable metastatic nodes, altogether 14 cases. Thus Groups I and II comprise the operable cases.

The greatest number of cases, 22, belong to *Group III*. These cases exhibited either large, extensive lip recurrences, involving the surrounding tissues, with or without fixed metastases to the glandular regions. Hence all were inoperable.

The *results of treatment* in the 38 cases, which have been observed for more than 3 years, will be seen from the figures given below. (Patient No. 39 is still free from symptoms to date, but has only been under observation for 2 years.)

	Free from symptoms	Died from intercurrent disease	Died from cancer
Group I	3		
» II	11	1	2
» III	6		15

All Patients belonging to *Group I* are thus free from symptoms. In *Group II*, which also comprises operable cases, 2 have died of cancer. Of the inoperable cases, *Group III*, 6 patients remain entirely free from symptoms after 3 years, while 15 have died from their disease. In all cases except 3 in the last-mentioned group, however, an evident improvement was noted after the treatment, and 2 cases remained clinically free from symptoms for $^1/_2$ and 1 year respectively.

35 cases have been observed for at least 5 years, and the results are the following:

	Free from symptoms	Died from intercurrent disease	Died from cancer
Group I	3		
» II	8	3	2
» III	3		16

The 3 cases belonging to Group I are still free from symptoms. The number of deaths from cancer in Group II is still unchanged, but 2 more have died from intercurrent disease. In Group III another patient has died of cancer (in a recurrence after 4 years' freedom from symptoms).

Treatment procedure: Before 1929 operative recurrences in the lip were treated in the same manner as primary tumours with radium pro-

theses. The metastatic nodes were usually irradiated with roentgen rays in a dose of 1—1½ S. E. D., sometimes with radium protheses at a distance of 3 cm., in a few instances with a combination of both.

After 1929 one small operative recurrence in the lip was treated with radium needles, another similar case with prothesis, but the remaining 8 cases were treated with teleradium in a dose of 14,000—20,000 mg. hrs. per field in several fields to the glandular regions and the lip tumour.

The surgical method of treating lip cancer is the oldest, and is still regarded by many surgeons, especially in Germany, as preferable to the radiological treatment. On that account I will give below, for the sake of comparison, some published results of treatment obtained at various leading surgical and radiological clinics. It should, however, be borne in mind that the surgical statistics refer to *operable* cases, while the radiological comprise the entire material of lip cancers, i. e. both *operable* and *inoperable* cases.

In 1906 ARMKNECHT published the results in 28 operable cases of lip cancer from HEIDENHAIN's clinic during the period 1897—1905, in which he records 80 per cent. healed cases after 3 years. HEIDENHAIN also mentions that with a simultaneous removal of the glandular regions 90 per cent. healing is reached and without removal 60 per cent. healing.

According to STEWART-HARRISON, who made a critical analysis of ARMKNECHT's primary material in 1933, these good results are, however, estimated too optimistically, for 5 of the 28 cases had been observed for a shorter period than 3 years. He gives an optimal healing figure after 3 years of 65.2 per cent., in ARMKNECHT's cases.

In a good many surgical lists, with a large and well arranged material, the average healing figure for lip cancer keeps between 50 and 60 per cent., 70 per cent. at most. As examples, the following may be mentioned:

STEINER (1908) mentions that of 43 operated cases 35, or 70 per cent., were free from symptoms after 5 years.

NYSTRÖM (1917) estimates in 241 operated cases of lip cancer in Sweden a 5-year freedom from symptoms of about 60 per cent.

MEINER (1923) mentions freedom of symptoms in 52.3 per cent. after 3 years.

KENNEDY (New York) published in 1934 a record of 246 cases of operated lip cancer. Of 147 after-examined cases, 67 per cent. are free from symptoms; 60 of these cases for more than 3 years and 31 for more than 5 years. Of 32 cases with metastatic nodes 34 per cent. are free from symptoms, 7 for more than 3 years.

In contrast to the very scanty publications from surgical quarters, quite a number of classifications have been published in recent years by radiologists.

As already mentioned, in 1924 FORSSELL published the results from Radiumhemmet at Stockholm. At that institute 66 cases of cancer of the lower lip were treated during the period 1910—1917, and after 5 years 68 per cent, of the entire material and 86 per cent, of the operable cases were found to be free from symptoms.

From »Institut de Radium» in Paris REGAUD reports in 1925 61.6 per cent. of the cases free from symptoms for a period of 1—7 years; this figure, however, does not include cases which have died from intercurrent diseases.

In a later report published in 1929 from the same clinic, LACASSAGNE in 103 cases of the lower lip records a 3-year healing of 65 per cent. If the deaths from intercurrent diseases are included the figure will be 72 per cent. For the operable cases comprising Stages I and II alone the corresponding figures will be 80 and 90 per cent.

In 1931 BERVEN reports in LAZARUS' handbook later results from Radiumhemmet: 287 treated cases show a 3-year healing of 69.7 per cent, and a 5-year healing of 64.2 per cent.

HAYES MARTIN, who has acquired great experience at the Memorial Hospital, New York, where over 1,000 cases of lip cancer have been treated, records in 1931 a relative 3-year healing of 87 per cent.

COLLIN (1932) at Copenhagen records a 3-year healing of 80 per cent, in 111 cases, of which 10 cases, however, have been excluded, some of which were hopeless from the beginning and some could not be found for control examination. If these 10 cases are included the figure will be 72 per cent.

SCHREINER and MATTICK (1933) obtain for lip cancer without metastases a relative 5-year healing of 71.9 per cent and in cases of lip cancer with palpable but inoperable metastatic nodes a corresponding figure of 29.6 per cent.

WIDMAN in Philadelfia (1934) has in 125 cases without metastases to the lymph-nodes a primary freedom from symptoms of 62 per cent, and a 3-year healing of 38 per cent.

Finally, SCHINZ (1937) reports the results — 24 cases — of lip cancer treated during the period 1919—1935. This material is certainly too small to permit any definite conclusions to be drawn, but a comparison is made with a similar material at the same clinic between cases treated surgically and cases treated radiologically. In 1919—1928 11 cases were thus treated only operatively, and these showed a 3-year and a 5-year healing of 45 per cent. In 1929—1935 13 cases were treated radiologically

only in this treatment the 3-year healing amounted to 42 per cent, and the 5-year healing to 60 per cent.

From the above cited figures from a number of different leading surgical and radiological clinics it will be seen that the results in irradiation therapy bear comparison very well with the results obtained in surgical therapy. It has been stated by many workers, also by radiologists, that irradiation therapy in lip cancer is of the greatest importance from a cosmetic point of view, but we now find that irradiation therapy on an average gives a 3-year healing of about 70 per cent, in the entire material of both operable and inoperable cases, while surgeons in only a few instances reach this figure in their material of operable cases. The results of the investigation of the Lund material further emphasizes the view advanced by radiologists that irradiation treatment of lip cancer is absolutely the superior method of treatment.

SUMMARY

The present material comprises 265 cases of cancer of the lower lip, treated during the period 1914—1934 at the Radiological Clinic in Lund.

In all cases the lip tumour was treated with radium, prior to 1928 by the application of radium by means of protheses to the tumour, after 1928 by means of intubation of the radium intratumourally.

Metastatic nodes have been treated partly by roentgen rays in the majority of cases by teleradium. In a number of cases residue nodes have been extirpated in a later sitting.

Of the 181 *operable cases* 153, or 84.5 per cent., are free from symptoms after 3 years. If 17 patients who died from intercurrent diseases are included, the figure will be 93.9 per cent. The corresponding figures after an observation period of 5 years are 69.1 and 90.8 per cent.

Of the 21 *inoperable cases* 28.6 per cent, were free from symptoms after 3 years, together with the 2 patients who have died from intercurrent disease the figure will be 38.1 per cent. The corresponding figures after an observation period of 5 years are 25 and 35 per cent. (no more patients have died from intercurrent disease during this period).

For the *entire material*, both operable and inoperable cases, the results of the treatment after 3 years will be 78.7 per cent. (88.1 %) symptom-free cases and after 5 years 63.9 per cent. (84.3 %).

ZUSAMMENFASSUNG

Das vorliegende Material umfasst 265 Fälle von Unterlippencarcinom, die in den Jahren 1914—1934 an der Radiologischen Klinik zu Lund behandelt worden sind.

In sämtlichen Fällen wurde der Lippentumor mit Radium behandelt, vor 1928 durch Anlegen von Radium mittels Prothesen gegen den Tumor, nach 1928 durch intratumorale Intubation des Radiums.

Die Drüsenmetastasen wurden teils röntgenbehandelt, teils, und zwar in der Mehrzahl der Fälle, teleradiumbehandelt. In einem Teil der Fälle wurden in einem späteren Eingriff die restlichen Drüsen exstirpiert.

Von den 181 *operablen Fällen* sind nach 3 Jahren 153 oder 84.5 % frei von Symptomen. Zählt man hierzu 17 an interkurrenten Krankheiten verstorbene Patienten, so

ergibt sich der Prozentsatz 93.9. Die entsprechende Zahl nach 5 Jahren ist 69.1 % bzw. 90.8 %.

Von den 21 *inoperablen Fällen* waren nach 3 Jahren 28.6 % ohne Symptome, einschl. 2 an interkurrenten Krankheiten gestorbenen Patienten 38.1 %. Nach 5 Jahren ist die entsprechende Zahl 25 bzw. 35 % (inzwischen waren keine Patienten an interkurrenten Krankheiten verstorben).

Für das *Gesamtmaterial*, sowohl operable als inoperable Fälle, ist Symptomfreiheit zu verzeichnen nach 3 Jahren in 78.7 % (88.1 %) und nach 5 Jahren in 63.9 % (84.3 %) der Fälle.

RÉSUMÉ

Ce travail statistique porte sur 265 cas de cancer de la lèvre inférieure, traités pendant les années 1914—1934 à la Clinique radiothérapique de l'Université de Lund.

Pour l'ensemble des cas, l'épithélioma de la lèvre a été soumis au traitement par le radium, avant 1928 à l'aide de la curiethérapie de surface par appareil moulé, à partir de 1928 à l'aide de la radiumpuncture.

Une partie des territoires lymphatiques a été soumise à la roentgenthérapie, mais dans la plupart des cas on a employé une irradiation par la télécuriethérapie. Pour une partie des cas, une extirpation de ganglions restants a été faite plus tard.

Des 181 *cas opérables*, 153 (84.5 p 100) montrent après 3 ans une absence totale de signes de cancer. Si on y joint les 17 morts par maladies intercurrentes (sans signe de cancer au moment de la mort), le chiffre sera 93.9 p 100. Après 5 ans d'observation, les chiffres correspondants sont 69.1 p 100 et 90.8 p. 100.

Des 21 *cas inopérables*, 28.6 p 100 restaient après 3 ans sans signes de maladie; avec les deux morts par maladies intercurrentes, on a 38.1 p 100. Après 5 ans d'observation, les chiffres sont 25 et 35 p 100 (pendant ce temps, on n'a eu aucun mort par maladie intercurrente).

Pour *l'ensemble des cas* (opérables et inopérables), les résultats sont: après 3 ans, guérison 78.7 p 100 (88.1 p 100); après 5 ans, guérison 63.9 p 100 (84.3 p 100).

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VENOGRAPHY IN A CASE OF SO-CALLED TRAUMATIC THROMBOSIS OF THE AXILLARY VEIN[1]

by

Olof Andersson

The peripheral vascular system is not accessible to direct investigation on a röntgen plate except in cases with calcification of the vessel walls. Nevertheless attempts were early made to fill the blood vessels with opaque material. The difficulty of finding a suitable contrast medium resulted in the method being used chiefly in animal experiments or on anatomical preparations. The substances employed were bismuth oil (FRANK & ALWENS), lipiodol (SICARD & FORESTIER) etc. and were not clinically practical because of the danger of embolism. Experiments were then made with halogen derivatives such as strontium bromate (BERBERICH & HIRSCH) and especially sodium iodide (DOS SANTOS and others). Neither are these derivatives, however, free from danger for they may injure the intimal coat of the vessels. The introduction of urography brought with it a new group of opaque substances where the iodine complex was organically combined so that they could be injected intravenously with little or no irritating effect and with good contrast results (uroselectan, perabrodil etc.). And finally, even colloidal solutions such as thorotrast have been utilized without giving rise to any irritating effect on the injected vessel. However, it is not yet positively ascertained whether these latter media are entirely without injurious consequences.

Since the introduction of serviceable opaque substances angiography has aroused an increasing interest and especially arteriography which is now used in encephalography, the localization of emboli etc. Aortography should also be mentioned in this connection (DOS SANTOS). Venography has remained more in the background and has not yet arrived at the stage of actual clinical applicability, but it has inspired a number of papers on the anatomical relations of the blood vessels (SCHMIDT; FREY & ZWERG; DEMEL, KOLLERT & SGALITZER; WOHLLEBEN). FRIMANN-

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Fig. 1. Normal venogram. Contrast material injected into cephalic vein.

DAHL made use of venography to evaluate the speed of the venous current in his postoperative röntgen studies. Finally, venography has been resorted to in some cases of so-called traumatic thrombosis of the axillary vein (LÖHR, LJUNGGREN, DEMEL & SGALITZER). We have had an opportunity to test out the method on a similar case and in a few other instances for differential diagnostic purposes. We have also done a number of venographies on normal patients in connection with ordinary urography. Our experience is thus confined to venography of the upper arm.

The technique is simple and resembles an ordinary intravenous injection into a cubital vein with the patient recumbent and the arm slightly abducted. The contrast effect is obtained with the same substances as in urography (uro-selectan, perabrodil etc.) and usually requiers 3 to 4 cc.

Fig. 2. Normal venogram. Contrast material injected into basilic vein and filling brachial vein.

An exposure is taken during the injection or exactly at its completion and reveals the injected vessel filled up as far as the axillary vein. In this vessel or in the subclavial vein the contrast effect disappears, usually at the level of the clavicle because of the inflow of blood from so many large veins and the consequent dilution of the medium. The cubital fossa contains three superficial large veins, one of which is the lateral cephalic, which continues up in the lateral biceps furrow and runs in an arch above the humeral socket emptying into the axillary vein often in conjunction with the thoracoacromial. Medially lies the basilic vein which runs in the medial biceps furrow and at about the junction of the lower and middle third of the arm passes through the fascia to lie more deeply and empty into one of the brachial veins which usually as two concomitant vessels

Fig. 3. Normal venogram. Contrast material injected into the median cubital vein with filling of both the cephalic and brachial veins.

follow the artery upwards to continue as the axillary vein. Finally, there is the median vein which forms a short oblique connection between the two previously mentioned vessels. A normal venogram shows unequal filling of these venous stems (Figures 1 to 3). It seems that to obtain the best possible filling of the axillary vein, the injection should be made into the basilic or possibly into the median cubital. Injecting into a superficial vein plays a minor rôle in the case of the arm where the superficial veins are throughout life of great importance for venous drainage, a state of affairs not found in the superficial veins of the lower extremity. Another difference is that the veins of the arms lack sufficient anstomoses with the superior vena cava to be able to form a compensatory collateral circulation.

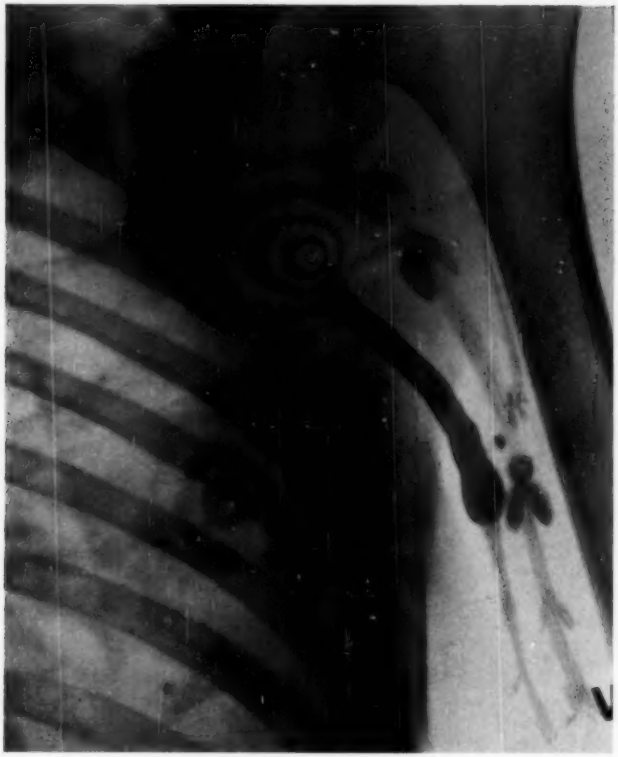

Fig. 4. Venogram from the case with the obstruction in the axillary vein. The contrast material reveals well filled veins and their valves and a well developed collateral running along the thoracic wall, the lateral thoracic vein, as well as a couple of smaller costoaxillary veins.

Obstruction in the venous drainage can of course be due to a thrombosis or a compression of the vessel by tumours, lymph nodes or masses of callus. In such cases venography can provide information as to the venous drainage through collaterals and sometimes even as to the site of the obstruction. A fresh thrombosis should probably be regarded as a counter-indication for venography on account of the hazard of embolism.

So-called traumatic thrombosis of the axillary vein offers a certain amount of interest to a röntgenologist, not alone from the standpoint of differential diagnosis in diseases of the shoulder joint. The condition is rare and the available literature seems to contain accounts of not quite 100 cases. The first observations are ascribed to SCHROTTER in 188[illegible] and

PAGET 1875. Several cases have also been reported from Sweden (STRÖMBÄCK, LJUNGGREN, KARTH and ROSELL). The clinical picture is quite characteristic. The symptoms begin with a more or less rapidly developing stasis and swelling of the arm. Gradually cyanosis develops and distention of the cutaneous veins of the arm and pectoral area. The patients describe the subjective symptoms as a feeling of tiredness and weight in the arm, sometimes even gentle pains. There is often slight tenderness in the axilla where the vein may occasionally be palpated as a firm cord. In most instances the patients are young, healthy individuals, usually men (75 %) and, remarkably enough, generally strong muscular types. In 80 % of patients the symptoms are confined to the right arm. Under conservative treatment with rest, eventually combined with heat in some form, the symptoms usually recede in the course of one or two months. Recurrences are, however, common and for this reason LÖHR has suggested the name claudicatio intermittens venosa. Patients have no symptoms elsewhere. The temperature and pulse are normal. In a few of the cases in the literature there was mild cardiac failure and in two a polycythemia (LÖHR). Naturally this disease picture should be differentiated from that due to definite thrombosis extending from the periphery or arising in connection with injection etc.

The etiology is not clear and a number of theories have been advanced in the literature. All are, however, agreed that the exciting factor is trauma. In most cases the patient tells of an indirect trauma, usually protracted and strenuous, such as unaccustomed work (beating rugs, chopping wood, putting up curtains, sports such as golf, tennis, rowing etc.). Trauma can, however, only activate the symptoms. There must also be a primary factor. At first the condition was interpreted as a genuine thrombosis probably due to intimal injury of some sort (thrombose par effort of the French). However, in the operated cases it has turned out that no thrombus was to be found and that there must be an obstruction of some other type which in conjunction with trauma brings about a stasis or delayed venous drainage. LÖHR assumes the presence of overextension of the veins in connection with overexertion. Others have suggested a compression of the vein by fascial and muscular fibers The axillary vein lies rather tightly embedded under the clavicle and is covered and protected by the insertion of the coracoid fascia. By means of detailed anatomical studies LÖWENSTEIN was able to demonstrate that in some individuals the costocoracoid ligament produces a compression of the axillary vein during abduction of the arm and he believes that this is a prerequisite for the development of the symptoms. The French have assumed a venospasm due to traumatic irritation of the svmpathetic. No clear explanation has been arrived at and etiological factors have only been discovered in the cases successfully operated upon. In a few of

these the vein had been compressed by fascial fibers. These were divided and the patient became symptom free (LÖHR, LJUNGGREN). In one case operated upon by WULTEN the vein had been strangled by the so called LASCHER axillary arch, a tendonous muscular bundle which passes above the axilla from the latissimus dorsi to the pectoralis major and which is said to be present in 7 to 8 % of individuals. In a patient operated upon by LÖHR the compression was produced by an enlarged lymph node. These cases reported by LÖHR and by LJUNGGREN were subjected to venography both before and after operation. DEMEL and SGALITZER also mention the value of venography in connection with two of their cases. In one the venogram revealed a slight indentation of the subclavian vein which they regard as due to an apical lesion and in another they could demonstrate contrast defects due to a thrombosis in the brachial and axillary veins as well as a smaller thrombus in the subclavian.

Our case from St. Erik's Hospital was cared for from January 3 to 25 1936 in the Third Medical Clinic (Chief Dr. E. SAHLGREN) and has already been published by Dr. G. AHLBERG in the Reports of the Swedish Society for Internal Medicine. The patient was a woman 26 years of age who had previously been in good health. She had a job in a library where she usually did office work. After putting up books in the fall of 1935 she noticed in December of that year a swelling and sense of weight in the left arm as well as prominence of the superficial vessels of the upper arm and axillary region. She had otherwise no subjective discomfort and kept on at first at her work. On admission to hospital her journal reads: »Average physical development, good general condition. Temperature and pulse normal. Sedimentation Reaction 3 mm. in one hour. Röntgen films of heart, lungs, mediastinum and shoulder joint reveal no abnormality. No cervical ribs. Blood count normal. Blood calcium normal. Bleeding and coagulation time normal. Blood pressure 120/50. Wasserman negative. Locally the left arm shows a diffuse moderate degree of swelling. The circumference of the upper arm is 4 centimeters and the forearm 2.5 centimeters greater than the right arm. Motor power and sensibility not abnormal. Enlargement of the veins on the upper third of the left upper arm extending up into a venous network over the axillary joint and infraclavicular region. No superficial veins are visible over corresponding areas on the healthy side.

Venography shows the veins of the upper arm well filled and with prominent valves The contrast material reveals sharper and more irregular contours in the axillary vein than in a normal venogram. In addition the opaque substance fills a well developed collateral along the lateral thoracic wall, the lateral thoracic vein, as well as a couple of costoaxillary veins. The picture is thus that of an obstruction in the axillary vein but its nature is not definite. A venogram of the right arm revealed normal conditions. With rest and the application of warmth with short waves the symptoms receded, the swelling decreased and the patient had no subjective discomfort. A month after discharge from hospital there was still mild swelling and a new venogram revealed filling of the collateral vessels thus indicating the persistence of an obstruction to drainage in the axillary vein

A couple of other cases may be mentioned for differential diagnostic purposes. One is that of a sea captain who during a trip to South America plus protracted exertion developed rather acute swelling of the right arm and symptoms rather similar to the above except that there was no cyan-

osis and no prominence of the superficial veins. The condition was at first believed to be parasitic in origin but it turned out to be a carcinoma with blockage of the lymphatics. The other case was a patient who had a cervical rib syndrome with occasional swelling and signs of mild stasis in both arms. Connective tissue fibers often extend from these cervical ribs close to the vessels down to the first rib and the symptoms are regarded as partially due to pressure on these vessels. In both instances, however, venography provided no evidence of venous obstruction.

We have thus only one genuine case to report but we wish to stress the value of venography as an auxiliary to diagnosis in conditions with evidence of venous obstruction in the upper extremities. The method can provide information as to the collateral circulation and sometimes even as to the site and type of the obstruction. Although in these cases of so-called traumatic thrombosis of the axillary vein there is said to be no danger of embolism, nevertheless, the procedure is counterindicated in fresh cases of genuine thrombosis.

SUMMARY

The author reports a case of so-called traumatic thrombosis of the axillary vein and stresses the value of venography which makes possible the demonstration of the collateral circulation and may even provide information as to the site and type of obstruction in these cases of venous stasis in the upper extremity.

ZUSAMMENFASSUNG

Verf. berichtet über einen Fall von sogenannter traumatischer Thrombose der Axillarvene und betont den Wert der Venographie, die es ermöglicht, das Zustandekommen der Kollateralzirkulation zu demonstrieren, und in diesen Fällen von venöser Stauung in der oberen Extremitäten auch Aufschlüsse über den Sitz und Typus der Obstruktion geben mag.

RÉSUMÉ

L'auteur rend compte d'un cas de thrombose dite traumatique de la veine axillaire et souligne la valeur de la vénographie, qui rend possible la démonstration de la circulation collatérale et peut même fournir des indications au sujet de l'emplacement et du type d'obstruction dans ces cas de stase veineuse dans l'extrémité supérieure.

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AUS DER RÖNTGENABTEILUNG DER UNIVERSITÄTSKLINIK IN UPSALA
(CHEF: PROF. H. LAURELL)

EIN FALL VON REINER COLONINVAGINATION[1]

von

Bengt S. Holmgren

Reine Coloninvaginationen auf Tumorgrundlage werden zu den seltensten Invaginationsformen gerechnet. Dagegen sind ileozökale Invaginationen auf Tumorbasis nicht ganz so ungewöhnlich. EHNMARK hat nicht weniger als 6 solche beschrieben, die auf der hiesigen Röntgenabteilung diagnostiziert worden sind.

Im Jahre 1933 hat LAURELL eine Zusammenstellung der bis dahin in der Literatur beschriebenen, mit Röntgen diagnostizierten Fälle reiner Coloninvagination (7 Stück) veröffentlicht und ausserdem einen äusserst lehrreichen eigenen Fall mit einer solchen Invagination geschildert. Dieser letztere Fall wird durch eine Reihe sehr interessanter Röntgenbilder veranschaulicht.

Die Röntgendiagnose ist vielfach schwer, wenn die Untersuchung nicht in der richtigen Weise durchgeführt wird und der Untersucher nicht mit den wechselnden Bildern vertraut ist, welche auftreten können. Im Jahre 1932 hat M. P. PORCHER drei fehlgedeutete Fälle veröffentlicht. Die Röntgenbilder schienen für Coloninvagination zu sprechen, aber die nachfolgende Operation stellte klar, dass eine Fehldiagnose vorlag. Leider werden in der Arbeit keine Röntgenbilder wiedergegeben. 1934 gab M. CESARINI eine kurze Zusammenstellung der bis dahin beschriebenen Fälle von reiner Coloninvagination (9 Stück = die 8 in LAURELLS Arbeit + 1 von GIUNTOLI)[2] und teilte ausserdem einen eigenen Fall mit (referiert in Zentralbl. f. Radiol.): 38-jährige Frau mit Symptomen eines chronischen Ileus seit 4 Wochen. »Im linken Oberbauch ist ein apfelsinengrosser Tumor fassbar. Röntgen: bei oraler Passage Unterbrechung der normalen Haustrierung des Dickdarms knapp vor der linken Biegung, dort sind mehrere Ringfiguren sichtbar. Bei Kontrasteinlauf vorüberge-

[1] Bei der Red. am. 3. III. 1938 eingegangen.

[2] GIUNTOLIS Aufsatz war mir weder im Original noch im Referat zugänglich.

hender Stop an dieser Stelle. Operation: Invagination, wobei das Coeco-Ascendens und das proximale Transversum bis zur distalen Hälfte invaginiert sind. Ursache der Invagination war ein etwa eigrosses submuköses Lipom.» Leider war mir diese Arbeit nicht im Original zugänglich. K. MENDL hat 1935 einen Fall von intermittierender Invagination des Colon sigmoideum, hervorgerufen durch einen Polypen, beschrieben. Die beigefügten Röntgenbilder geben jedoch meines Erachtens keinen Beleg dafür, dass es sich um eine Invagination handelte, sondern zeigen nur zwei Polypen im untersten Teil des Colon sigmoideum, die auch bei der nachfolgenden Operation festgestellt wurden. Ferner hat E. ZDANSKY 1935 in einigen Zeilen über die Invagination im Sigma bei Kolitis berichtet. L. DELOYERS hat 1936 einen Fall von Kanzer im Colon descendens mit Invagination geschildert, wo indes die Diagnose nicht nach der Röntgenuntersuchung, sondern erst bei der Operation gestellt werden konnte.

Auf der hiesigen Röntgenabteilung ist kürzlich ein weiterer Fall von reiner Coloneinstülpung auf der Grundlage eines Tumors im Colon ascendens diagnostiziert worden. Da die Literatur sehr arm an solchen Fällen ist, dürfte eine Mitteilung desselben vielleicht von Interesse sein. Im übrigen verweise ich auf LAURELLS Aufsatz über den Gegenstand.

J. Chir. Nr. 3387/37. K. R., 65 Jahre. Seit 3 Monaten hatte Pat. fast ständig Schmerzen im ganzen Bauch gehabt. Unmittelbar nach jeder Mahlzeit bekam er, unabhängig von der Art der Nahrung, Leibschneiden, das ungefähr eine Viertelstunde anhielt. In der letzten Zeit war der Stuhl normal, früher oft locker. Weber negativ in wiederholten Proben. Bauch weich und nicht druckempfindlich, keine pathologischen Resistenzen tastbar.

Röntgenuntersuchung von Ventrikel und Duodenum am 3. 12. 1937 ergab nichts Pathologisches. Dünndarmpassage normal. Nach 5 Stunden hatte der Kontrast die Flexura lienalis erreicht. Ileum relativ stark kontrahiert. An der rechten Colonflexur sah man einen Defekt in dem Kontrast, der Verdacht auf eine kleine Invagination auf Tumorbasis weckte, weshalb man die Untersuchung durch Kontrasteinlauf ergänzte.

Kontrasteinlauf in das Colon am 11. 12. 1937, als Pat. Schmerzen im Bauch hatte: Das Sigmoideum bot ein ausgesprochenes Bild von Sigmoiditis mit zahlreichen Divertikeln. Colon descendens und transversum waren ziemlich stark kontrahiert, füllten sich aber leicht bis in die Gegend der rechten Flexur. Dort stiess der Kontrast auf einen Widerstand, und man erhielt ein invaginationsartiges Bild mit einem konkaven Abschluss des Kontrastes (Fig. 1). Nach ein paar Minuten, als sich der Darm besser gefüllt hatte, war der Apex invaginati eine kurze Strecke in oraler Richtung verschoben worden. Fig. 2 zeigt den Apex invaginati unmittelbar oral von der gesenkten rechten Flexur. Man sieht, wie der Apex eine Aussparung im Kontrast hervorruft, und medial vom Apex einen nahezu

Fig. 1. Die Gegend des Apex invaginati wurde beim Photographieren mit einer gestielten, gedrechselten Holzkugel zusammengedrückt, die auf dem Bilde sichtbar ist.

Fig. 2.

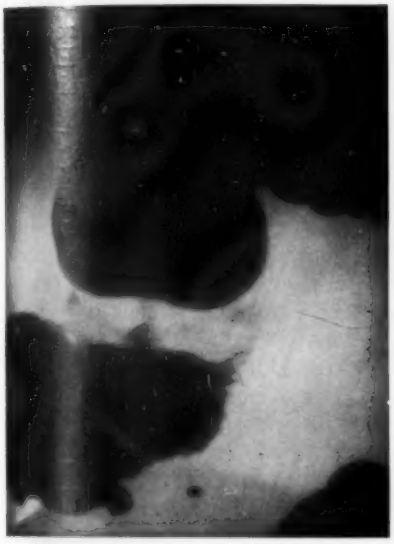

Fig. 3.

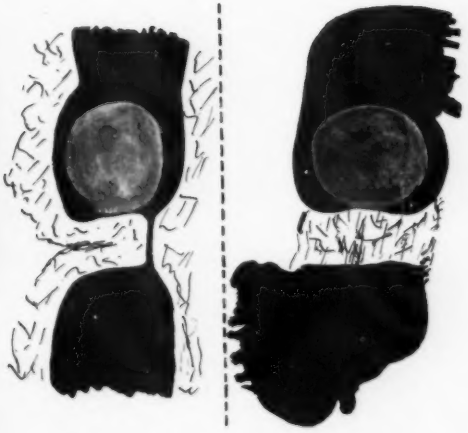

Fig. 4 a. Von der Seite gesehen.

Fig. 4 b. Von vorn gesehen, analog Fig. 3.

Die querverlaufende Einbuchtung entspricht einer lateralen Invagination mit einem Tumor als Leiter.

isolierten Teil eines kontrastgefüllten Haustrums. Nach einigen weiteren Minuten hatte sich der Apex noch mehr in oraler Richtung verschoben, und man erhielt das Bild, welches Fig. 3 zeigt. Dasselbe ist unmittelbar vor Vollendung der Desinvagination, nachdem ein Teil des Kontrastes in das Cœcum hinabgegangen war, aufgenommen. Das Bild dürfte einer lateralen Einstülpung mit einem Tumor als Leiter entsprechen, und die

Fig. 5.

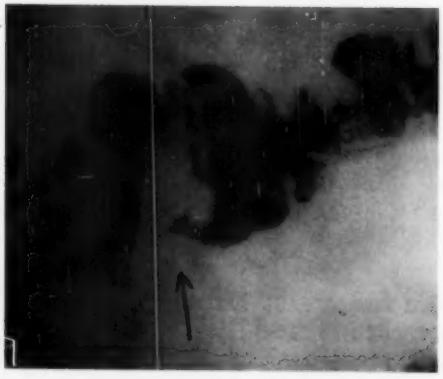

Fig. 6. Der Patient in fast gerader Seitenlage photographiert. Der Pfeil bezeichnet den Tumordefekt.

grossen Fettmassen a der Colonwand (siehe den Operationsbericht weiter unte) erklären die relativ breite Zone, die nur unbedeutend kontrastgefüllt ist (Fig. 4). Im nächsten Augenblick ist die Desinvagination vollendet, und das ganze Cœcum und Colon ascendens sind kontrastgefüllt und sehen normal aus (Fig. 5). Ein Tumor ist nicht sichtbar. Der Appendix hat sich mit Kontrast gefüllt. Während der Desinvagination stieg die rechte Flexur etwas in die Höhe, und der Darm erweiterte sich.

Pat. durfte nun den Kontrast wieder von sich geben, worauf, nachdem der Darm fast leer geworden war, ein Tumordefekt oberhalb der Valvula Bauhini auftrat (Fig. 6). Man sieht hier den Tumordefekt an der Vorderseite der Darmwand liegen. Pat. hatte nun keinerlei Bauchbeschwerden. Nachdem man eine Weile gewartet hatte, traten wieder Schmerzen im rechten Teil des Bauches und *vor allem medial vom Colon ascendens* auf. Auf dem Bild, das man nun aufnahm (Fig. 7), sieht man, wie sich die Einstülpung wiederbildet. Der kontrastbelegte und deshalb unsichtbare Tumor ist Leiter und hat die Haustrierung völlig in dem Gebiet ausgeglättet, wo er nun liegt (im

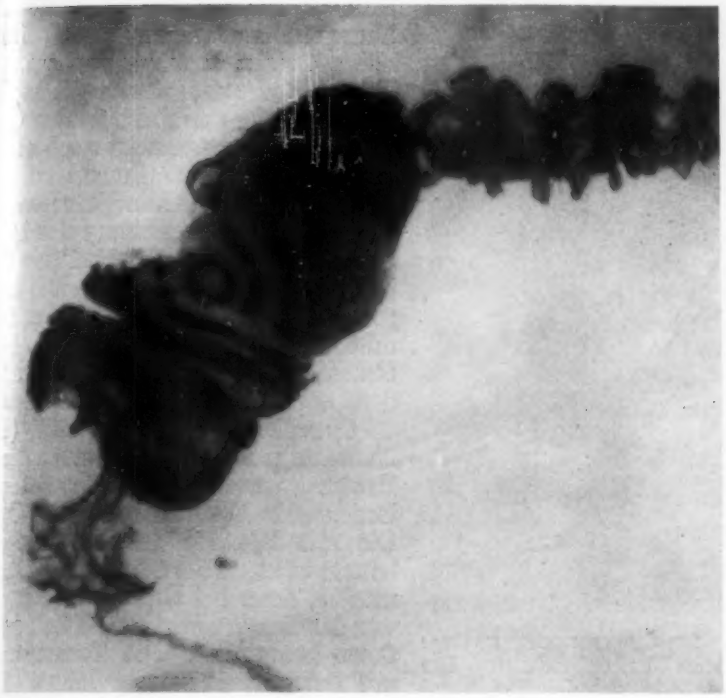

Fig. 7. Die ausgebildete Invagination mit Cœcum und Processus vermiformis oral davon.

rechten Teil des Colon transversum). Aboral von der Invagination ist das Colon transversum stark zusammengezogen. Die rechte Colonflexur ist fast völlig verwischt und gesenkt. Oral vom Tumor sieht man die ziehharmonikaartig gefaltete äussere Scheide. Unmittelbar oral von dieser folgt das schmale Collum invaginati mit dem zuführenden Darmrohr, dem wenig kontrastgefüllten Cœcum. Das letztere weist unregelmässige, gehirnwindungenartige Schleimhautfalten auf. Das Colon ascendens ist am Halse stark zusammengedrängt und zeigt dort längsverlaufende, parallelle Falten, worauf es sich mit dem gleichen Aussehen in die Invagination als deren inneres Rohr fortsetzt. Das Schleimhautrelief in dem inneren Rohr wird in diesem Fall von dem Kontrast in der äusseren Scheide verdeckt. Diese Längsfaltung dürfte u. a. mit dem Gedränge im mittleren Rohr und mit der Straffung des inneren Darmrohrs zusammenhängen. Am Halse und medial von ihm sieht

Fig. 8. Das Colon ascendens ist längs der hinteren Wand aufgeschnitten. Der Tumor befindet sich ungefähr in der Mitte des Bildes. Das Ileum liegt links unten, der Prozessus vermiformis in der rechten unteren Ecke.

man einen unbedeutenden Kon astklumpen, der wahrscheinlich i der alleruntersten Ileumpartie liegt. Das Ileum mündet mit grösster Wahrsc einlichkeit dicht am Halse in das C lon, und die Invagination ist noch al eine reine Coloneinstülpung anzusehen. Mit der weiteren Entwicklung der Inva ination und der Einbeziehung des Il ums in dieselbe geht die Einstülpung ndes in eine ileocœcale über. — Die Röntgenuntersuchung hatte also eine intermittente Coloninvagination auf der Grundlage eines Tumors im Colon ascendens ergeben. Deshalb schritt man zu

Operation am 15. 12. 1937 (Prof. NYSTRÖM): Resectio ileocœcocolica et Ileotransversostomia laterolateralis. Bedeutende Fettmassen um das Colon. Die mit Röntgen gestellte Diagnose konnte während der Operation bestätigt werden, denn bei Beginn des Eingriffs war der Tumor ein kleines Stück in das Colon invaginiert. Der Tumor wurde mit Leichtigkeit desinvaginiert. Hierauf resezierte man den untersten Teil des Ileum, das Cœcum, das Colon ascendens und das halbe Transversum und machte eine Anastomose zwischen Ileum und Colon transversum.

Das *Präparat* (Fig. 8) zeigte 5—6 cm aboral von der Valvula Bauhini an der vorderen Wand des Colon ascendens einen ungefähr pflaumengrossen, polypösen Tumor mit relativ breiter Basis und einer kleinhöckerigen Oberfläche. Er war etwas abgeplattet und graurot. P. A. D. Adenokarzinom.

Nach der Operation war der Zustand in den ersten 24 Stunden gut, aber der Darm wollte nicht in Gang kommen. Pat. bot das Bild eines paralytischen Ileus. An diesem und einer Myocarditis chronica starb er 9 Tage nach der Operation trotz aller Versuche, die Peristaltik in Gang zu bringen.

Der hier beschriebene Fall beleuchtet in ausserordentlich instruktiver Weise, wie wichtig es ist, bei dem geringsten Verdacht auf Invagination im Colon (speziell chronische Coloneinstülpung, die gewöhnlich bei älteren

Personen vorkommt und auf der Grundlage eines Tumors steht) *während der Beschwerden Kontrasteinlauf* zu machen. Ferner zeigt er, von wie grosser Bedeutung es ist, dass der Patient *auch während und nach Entleerung des Kontrastes untersucht* wird. Besonders in den Fällen, wo die Invagination so leicht reponibel ist, dass man sie während des Eingusses übersieht oder keine typischen Invaginationsbilder erhält, ist dieses letztere Verfahren von unschätzbarem Nutzen. Man muss die Untersuchung dann ohne Übereilung vornehmen und eine Gelegenheit abwarten, wo der Patient von neuem Bauchbeschwerden bekommt, wobei man dann die Möglichkeit hat, die in Entwicklung begriffene Invagination zu beobachten und zu photographieren.

ZUSAMMENFASSUNG

Der Verfasser erwähnt in Kürze die aus der Literatur bekannten röntgendiagnostizierten Fälle von reiner Coloninvagination. Er berichtet über einen eigenen Fall und weist darauf hin, wie wichtig es ist, vermutete Coloninvaginationen mit Kontrasteinlauf während stattfindender Beschwerden zu untersuchen und die Untersuchung auch während und nach Entleerung des Kontrastes fortzusetzen.

SUMMARY

The author gives a brief review of the röntgen-diagnosed cases of genuine invagination of the colon in the literature and reports a case of his own. He stresses the importance of using injections of contrast material to examine suspected cases during the symptoms as well as during and after the excretion of the medium.

RÉSUMÉ

L'auteur cite brièvement les cas, décrits dans la littérature, de pure invagination du côlon diagnostiqués aux rayons roentgen. Il relate un cas personnel et attire l'attention sur l'importance d'examiner les invaginations du côlon suspectées, au moyen d'infusion de contraste pendant l'apparition des symptômes, de même que de continuer l'examen pendant et après l'évacuation du contraste.

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FROM THE ROENTGEN DEP'T OF THE VIBORG TOWN AND COUNTY HOSPITAL (DENMARK)

ON SCHMORL'S CARTILAGE ISLANDS[1]

by

Kristian Overgaard, M. D.
Chief Radiologist

At the German Congress of Pathology in 1927, SCHMORL reported on a series of investigations concerning the cartilage nodules, or »islands», in vertebrae, named after him. These formations, which had formerly been more or less overlooked, have since become recognised as frequent findings on roentgen examination of the spine. While for some time after their discovery there was a tendency to ascribe considerable importance to them as responsible for various affections of the back, the more recent tendency has been to regard them as manifestations of no great importance. The correctness of the latter conception may be doubted, however. It is true that they often occur as incidental findings, giving rise to no actual symptoms; but in many other instances they are accompanied by symptoms more or less vague; and occasionally the roentgenologic picture is of such a character, and the accompanying symptoms so marked, that the diagnosis, specially from tuberculous spondylitis, can be a matter of considerable difficulty, as illustrated by the following case histories.

Case I. S. K., farm laborer, 24 years old. — When 11 years old he was in hospital under observation for spondylitis, having been suffering for about a year with pain in the lower part of his back. Examination showed the spine to be straight, slightly fixed. There was some direct and indirect tenderness corresponding to the second lumbar vertebra. Roentgen examination failed to disclose any positive pathologic changes (the films not preserved). After he had been kept resting in bed for eleven weeks the pain disappeared. Since then he has on the whole been feeling well, except for occasional indefinite pains in the back and some sense of tiredness. For the last two weeks he has had stronger pain in the loins when working; most so when bending over forwards. There are no signs of tubercular infection.

Objective examination shows a straight spine; no direct tenderness, but slight indirect tenderness about the lumbar portion. The spinal movement is free in all directions, but

[1] Submitted for publication Febr. 15, 1938.

bending forward causes pain. The patient can raise himself to a sitting positio in bed without support.

Roentgen examination, 10th Jan., 1936, in lateral projection, shows the welfth thoracic vertebra slightly wedge-shaped (Fig. 1). In its under surface, anteriorly 5 mm. from the anterior margin, is a semi-circular rarefaction 7 × 15 mm. large, sur ounded by a distinct sclerosed zone. The posterior portion of the rarefaction shows a flatter, but blurred design; yet also there a distinct densification of the bone. The re of the under surface of the twelfth thoracic, as well as the upper surface of the first umbar, are moderately sclerosed. Otherwise the structure of the vertebral bodies is normal. There are no signs of collapse or destructions. The interspace between the twelfth horacic and first lumbar is considerably narrower than the interspaces between the other v rtebræ. Anteriorly, the two margins are strongly marked, but there are no actual oste phytes. In the under surface of the eleventh thoracic is seen a smaller cartilage island; in the upper surface of the second lumbar another, larger; both with moderate sclerosis. The corresponding interspaces are not narrowed.

Repeated roentgen examinations showed the same picture, unaltered. The patient was put in plaster bed and treated with carbon-arc light baths until Sept. 1936, after which time he was free from pain.

Control examination, Oct. 1937: Subjective and objective freedom from symptoms. The roentgenologic picture unaltered.

Case II. A. L., farmhand, 28 years old. — Has during the last four-five years been suffering periodically from pains across the loins. They are greatest when he bends forward, or when he turns over in bed; while as a rule they are absent as long he is lying quietly in repose. They are localised to the first lumbar vertebra, with some slight radiation upwards and downwards. On the whole they have incerased in the last year. There are no signs of tubercular infection.

Objective examination shows a straight spine, with the lumbar lordosis almost completely straightened out. Movements are carried out very stiffly, specially those of the lower thoracic and upper lumbar portions. There is moderate direct and indirect tenderness of the area about the first and second lumbars. The patient can raise himself to a sitting position in bed without using his arms, and can pick up things from the floor without support.

Roentgen examination, 21st Nov., 1936, of the thoraco-lumbar spine, shows considerable narrowing of the interspace between the twelfth thoracic and first lumbar vertebræ (Fig. 2). The corresponding vertebral surfaces are slightly sclerosed. Posteriorly in the under surface of the twelfth thoracic there is a well defined rarefaction, 18 × 9 mm. large, sorrounded by sclerotic bone tissue. In the upper surface of the first lumbar there is a similar, but less distinctly contoured formation. Otherwise the structure of the vertebræ is normal; there are no signs of destructive processes; no gravitation abscesses. At the anterior margin of the vertebral interspace there is a slight accentuation of the edges of the vertebræ, with a development of small osteophytes.

Subsequent roentgen examinations showed the condition unaltered. The patient was kept flat in bed for 4 months, at the end of which time the pains had disappeared.

Control examination, 9th Oct. 1937: Subjective and objective freedom from symptoms. The roentgenologic picture unaltered.

Case III. C. O., farmhand, 15 years old. — Of sound stock; himself healthy during his growth. For the last eighteen months pains in the lower part of the back when doing any hard work, or work in a stooping position. In periods free from pains; but during the last few months they have increased considerably.

Fig. 1.

Fig. 2.

Objective examination: The patient is big and strong for his age. The general examination shows nothing abnormal. The spine is straight, without kyphosis or scoliosis. No indirect tenderness, but slight direct tenderness of the third and fourth lumbar vertebræ. He carries the whole lumbar portion of the spine very stiffly when moving.

Roentgen examination, 1st May, 1937, of the lumbar spine (Fig. 3), shows irregular design of most of the vertebræ. Their bodies are of normal height, the surfaces rather strongly, wavily curved; in several of them are seen distinct, clearly defined cartilage islands. The apophyses are of normal appearance and normally lodged. The structure of the vertebræ is natural; the interspaces of normal height. In the first lumbar is seen, anteriorly and inferiorly, a considerable defect, about 3 × 1 cm. large, fairly well delimited by a broad, somewhat diffluent sclerotic zone. In the defect can be seen a faintly traced bone shadow. In frontal projection (Fig. 4) the defect appears symmetrically developed across the whole width of the bone. In the second lumbar is seen a similar, but considerably less pronounced rarefaction. The interspace between these two vertebræ is considerably

Fig. 3.

Fig. 4.

narrower than those between the others of the series. There are no signs of gravitation abscess.

The patient was kept in bed for 2 months, with the result that the pains and stiffness disappeared.

Control examination, 9th Oct., 1937: No subjective symptoms. The boy is working. The movements of his back are completely free. Roentgen examination shows the former condition, unchanged.

We see that these cases have certain features in common. In young men occupied in hard physical work there develops a rachalgia localised to the lower portion of the back. During a long time (1 to 4 years) the

pains gradually increase; on the whole they are more severe during the performance of any heavy task, specially any such as requires stooping or bending over forward.

At the examination the back is carried stiffly. There is no positive direct or indirect tenderness of the spine; no signs of tuberculosis in other organs. On roentgen examination a distinct defect is seen in a single vertebra, but clearly delimited; sometimes similar, but smaller rarefactions in other vertebræ. The vertebral interspace with the largest bone defect is narrow, and the adjoining vertebral surfaces may be more or less sclerosed. At the margins of the vertebræ may be seen indications of deforming spondylitis. In appearance, these cases can resemble tuberculous spondylitis; yet both the clinical course and the roentgenologic picture seem to justify the rejection of that diagnosis, and to warrant us in ascribing the affection to the existing cartilage islands.

These formations were first described by LUSCHKA, but have in recent years been thoroughly studied and described by SCHMORL; and our knowledge concerning the pathology of the disease is based chiefly on his investigations:

In the case of any slight lesion to the layer of hyaline cartilage which separates the central part of the vertebral surfaces from the nucleus pulposus, there is a possibility that portions of that plastic body, — which furthermore is subject to considerable pressure, — may penetrate through the lesion in the cartilage disc, and thence, through the various foramina in the surface of the vertebra, into the spongy bone tissue in the central portion of the latter. By forcibly displacing the bone marrow, this may cause atrophy of the spongy tissue, with the result that in the bone tissue cavities are formed, which become filled with the prolapsed nucleus tissue. These cavities can vary in size from that of a pin-head to that of a hazelnut.

As a rule, the advancing prolapse rather soon becomes decapsulated through the formation of cartilaginous tissue along its periphery; and after such decapsulation has taken place the development of cartilage can continue towards the centre, so that the invading, turgescent, slightly fibrillated nucleus tissue is in its entirety transformed into cartilage tissue. This transformation of the fibrillary nucleus tissue into a cartilage island is due chiefly to a development of the interspersed cartilaginous elements; but the possibility of some participation on the part of the bone marrow cannot be excluded. On the other hand, the hyaline cartilage disc hardly takes any part in the process of transformation. Its fracture-edges can often be demonstrated, showing an entire absence of reaction. The bone tissue contiguous with the cartilage island often develops a fine, delimiting sclerosis, which plays a considerable rôle for the roentgenologic demonstration of such islands.

Under certain conditions other changes can develop in the prolapsed nucleus tissue. Mucid or hydropic degeneration may occur, though rarely; also transformation of the prolapsed tissue into bone tissue. On the other hand, ingrowth of vessels into the prolapse, accompanied by transformation of the nucleus tissue into fibrillary connective tissue, is rather common. In such cases, the vascular invasion may proceed further, through the defect in the cartilage disc into the nucleus itself, with the result that the latter becomes similarly destroyed and transformed into fibrous connective tissue. The nucleus thereby loses its turgor, and the elastic force of the intervertebral discs disappears. This condition manifests itself in a reduction in height of the intervertebral space; and very often there is a considerable development of sclerosis of the vertebral surfaces, and of osteophytes along the edges, of an appearance similar to what is found in spondylitis deformans; except that here the changes are confined to a single interspace. Cases of monotopic spondylitis are probably in most instances due to changes of this character. In most cases this reduction in height is due to degeneration of the intervertebral discs, and not to any diminution of the mass of nuclear substance owing to the prolapse. Only in the case of very large prolapses can such a diminution be supposed to play any rôle.

Akin to the development of these formations is, according to SCHMORL's description, the development of split-off portions of the epiphyseal ring, which is a frequent finding. The nature of these formations is much disputed. By JANKER and HELLMER they are described as persisting vertebral epiphyses; SCHMORL and BOEHMIG have looked upon them as a kind of strain fractures; but in a later work SCHMORL goes in for the supposition that they are developed through some cartilage formation which wedges itself in underneath the limbus at an early stage of the development of the latter, and prevents it from becoming fused with the rest of the apophysis in the normal way. Though it must still be considered as uncertain whether this conception of the origin holds good in all cases of so-called »persisting apophyses», it is probable that this was indeed the manner of development in a single case like no. III (C. O.), where there is a considerable defect inward toward the vertebral body, underneath the loose apophyseal ring.[1]

As the result of his pathoanatomical investigations, SCHMORL found such cartilage islands in 38 per cent., while WISSING by the roentgen examination of 421 spines found them in 13.5 per cent. This is easily explained by the fact that the roentgenologic demonstration is possible only after the prolapse has reached a certain extent, and that also some sclerotic demarcation on the part of the vertebral body is necessary.

[1] A case of similar character is described by K. SCHULTZE in the »Roentgenpraxis» IX, 461, 1937.

In the three cases reported here, there is a considerable resemblance, both clinically and roentgenologically, to the changes that may be seen in tuberculous spondylitis; and by a single inspection it may be difficult to decide whether such a condition exists or not. The pains in the back and the restrictions to movement are not characteristically different, though on the whole those symptoms may be expected to be more strongly pronounced in case of spondylitis. The same applies to the direct and indirect tenderness; which, however, can vary greatly also in spondylitis. The roentgenologic picture shows a defect in the body of the vertebra, and narrowing of the adjoining intervertebral space. At the same time there may be some slight sclerosis of the adjoining vertebral surfaces, and reactive processes as the edges of the latter. These changes are hardly present in the early stages of the affection, though; and similar processes may be found in tuberculous spondylitis. In the latter disease, the defects are, however, as a rule more extensive, and less clearly limited to the superior or inferior surface of the vertebra; specially are the defects only in the healing stage so sharply delimited as it is usually the case with a cartilage island. The multiple, homogeneous, sometimes almost symmetrical occurrence speaks strongly for the presence of cartilage islands. Gravitation abscess or collapse of the vertebra is not seen in connexion with a cartilage island; but is must be added here that the affection not infrequently occurs in combination with a juvenile kyphosis with considerable deformation of the vertebræ.

As already said, the occurrence of SCHMORL's cartilage islands is a frequent roentgenologic finding. In most cases they apparently produce no symptoms; nevertheless it seems reasonable to ascribe a certain pathologic significance to them; and it is to be desired that some closer attention may be given to its possible clinical importance. It must be supposed that the affection in itself can give rise to pronounced subjective symptoms, and also that it may play a certain rôle with regard to the development of a deforming spondylitis, and probably also with regard to the development of juvenile kyphosis (morbus Scheuermann).

SUMMARY

Three cases of SCHMORL's cartilage islands are reported, presenting clinically and roentgenologically considerable resemblance, to the changes that may be seen in tuberculous spondylitis.

ZUSAMMENFASSUNG

Verf. berichtet über 3 Fälle von Schmorls Knorpelinseln, die klinisch und röntgenologisch grosse Ähnlichkeit mit den Veränderungen zeigten, die man bei tuberkulöser Spondylitis vorfinden kann.

RÉSUMÉ

L'auteur rapporte trois cas d'»îlots» cartilagineux de Schmorl, présentant une ressemblance considérable, tant au point de vue clinique que roentgenologique, avec les modifications que l'on peut observer dans la spondylite tuberculeuse.

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(FROM THE CLINIC AND THE LABORATORY OF THE ANTONI VAN LEEUWENHOEKHUIS. DIRECTORS: DR. W. F. WASSINK AND R. KORTEWEG, AMSTERDAM)

SERIOUS INJURY OF THE BLOOD IN CONSEQUENCE OF TELEROENTGEN-THERAPY OF THE WHOLE BODY[1]

by

Dr. *D. den Hoed*, Dr. *B. Levie* and Dr. *M. Straub*

During the last few years the radiation of the whole body, or at any rate the greater part of it, has attracted general attention, partly thanks to the report given by MALLET at the International Cancer Congress at Brussels in 1936. It induced us to apply this method, on a relatively small scale, to patients with malignant tumors of a large extension, in the hope of thus finding a valuable weapon against this disease for patients for whom no other therapy can be considered.

The particular principles of this radiation are as follows. In cases of generalized tumors MALLET radiates the whole body from a distance of from one to three m. The body is sometimes treated in sections so as to decrease the general reaction, in which case the field area is at least 40 × 40 c. m. The daily dose stands at from 25 to 50 r, dependent on the clinical aspect and the reaction. The rays are generated at 200 KV and filtered through 0.5 mm Cu. In some cases radiation is applied daily, and at least four times a week. The time of exposure depends: 1. on the reaction of the tumors, 2. on the blood injury, which sets in fairly early in this method of treatment.

The highest dose per field area amounts to 1200 r, but mostly a much smaller dose suffices, of from 300 to 400 r. The body or the parts that are to be treated, are radiated from the front as well as from the back.

Within the course of a year we have treated twenty cancer patients, going by MALLET'S principles. Moreover, ten other patients, suffering from leukaemia and Hodgkin's disease, were radiated in the same manner.

Like MALLET we were guided by the blood formula; we always discontinued the treatment immediately the number of leucocytes had decreased under 3000 per cmm, the leucocytes being counted at least once a week. (MALLET takes as boundary-line 2500 leucocytes, and examines the blood but once every ten days).

[1] Submitted for publication March 10, 1938.

If necessary, radiation was resumed as soon as the number of leucocytes had increased to 4000 or 4500.

Without discussing our material at full length, we may state that this method has satisfied in but a few cases. This is hardly surprising in view of the seriousness of the disease in general, and in particular of these patients, who were almost beyond hope.

Summarizing our opinion, formed tentatively in the course of this year, we can state that in general we prefer the purely local treatment in case of lymphogranuloma, whereas we found that a radiation of the whole body may temporarily exert a very favourable influence on chronic leukaemia. For metastases in the bones, especially in patients with carcinoma of the breast, this method may bring unexpected, temporary, great improvements, while the best results are obtained with radiation of parts of the body, that is in those patients in whom the extension of the tumor is more or less limited, although too large to apply purely focal treatment.

It is well known that the method is very injurious to the bone-marrow, which is most evident from the blood-formula and, in accordance with literature, we found as a rule that after general irradiation:

I. the total number of leucocytes decreases rapidly,
II. the absolute number of polymorphonuclear leucocytes and lymphocytes diminishes seriously.

In nine cases treated by the method of MALLET, in which a more elaborate examination of the blood was performed, a slight relative increase in the stab and juvenile cells was determined three times; (one of these cases had bone mestastases). Twice the number of eosinophil cells decreased.

The red blood was apparently influenced to a far smaller degree by this method of irradiation; still a small decrease in the number of erythrocytes and in the haemoglobin content (Sahli) was present in five of these nine cases.

When examination of the blood was repeated a few months after terminating radiation, which could take place in a few patients, we found normal leucocyte values with relative lymphocytosis.

It became apparent that the course of the injury to blood and bone-marrow is not always so regular and so favourable as described before.

For instance we observed in some patients that the decrease in the number of leucocytes continued for weeks after the end of the irradiation (when the number was 3000) and assumed very dangerous forms. Thus in a few patients we found after one month as few as 400 leucocytes; in three cases we found hardly if any granulocytes (the latter patients were examined post mortem). Sometimes there arose an *enormous*

Table I

History 6918

	↓ 24/5 '37				↑ 9/6 '37		
Date	21/5 '37	29/5	4/6	11/6	18/6	24/6	29/6
Hb Sahli	91 %	90 %	86 %	87 %	82 %	79 %	—
erythroc.	3.920 mill.	3.920 mill.	3.480 mill.	3.630 mill.	3.840 mill.	2.930 mill.	— mill.
leuc.	6400	3700	3400	2400	2500	1200	763
eos.	1	1/2	1/2	—	1/2	—	—
bas.	1	—	—	—	—	—	—
metamyeloc.	3	—	—	—	—	—	—
stab cells.	6	1	3	3	3 1/2	1 1/2	1
poly. nucl.	69 1/2	68	79	73	72	15 1/2	2
lymphoc.	12	16	10 1/2	11	21	69	93
monoc.	7 1/2	14 1/2	7	13	3	13 1/2	2
megakaryoc.	—	1/2	—	—	—	—	—
Türck	—	—	—	—	—	1/2	2
normoblasts on 200 white cells.	2	—	—	—	—	1	—

↓ Onset of Mallet treatment.

↑ End of Mallet treatment.

Particulars of the blood formula.

29/5 37 no normoblasts.
4/6 no normoblasts.
11/6 polychromasia, anisocytosis, poikilocytosis.
18/6 slight toxic granulation.
24/6 hardly any thrombocytes in the slide, strikingly anaemic, on 200 cells 1 normoblast.
29/6 anisocytosis, poikilocytosis, no thrombocytes (high fever).

thrombopenia with in consequence severe haemorrhages of the gums, epistaxis and purpura.

Although serious injuries to the red blood could rarely be ascertained, we now know from literature[1] and from our own experience that a compensated destruction of the erythrocytes takes place (increased amount of bilirubin in the serum and increased percentage of supravital stainable cells). In some cases it seems that the production of new cells cannot come up to the demands, so that these patients showed anaemia, even where serious haemorrhages had not occurred.

In view of this deviating course in fairly numerous cases and the subsequent dangers, we now wish to mention the histories of 4 patients

[1] *Mardersteig*, Kl. Strahlentherapie, Vol. 59, p. 609.

Table II

History 7383

	↓ 24/5 '37			↑ 14/6 '37		
Date	24/5 '37	31/5	7/6	14/6	21/6	2/7 '37
Hb Sahli	91 %	90 %	90 %	84 %	83 %	0 %
erythroc.	4.390 mill.	4.580 mill.	4.150 mill.	3.950 mill.	3.887 mill.	3.075 mill.
leuc.	5810	5430	5375	2810	2625	885
eos.	2	4½	6½	7½	11	9
bas.	1	½	1½	1	1	1
myeloc.	—	—	1	—	—	—
stab cells.	½	½	1½	5	3½	6
polym. nucl.	67	66½	69½	60	63½	55
lymphoc.	19	15½	9½	11	9½	22
pathol. lymphoc.	½	—	—	—	1	2
plasmac.	½	—	—	—	—	—
monoc.	5½	12½	10½	15½	10½	5
supra vital	6'/00	10'/00	11'/00	17'/00	—	12'/00
sedim. rate after 1 and 2 hours.	44—75	47—77	53—86	51—82	47—83	64—102

↓ Onset of Mallet treatment.

↑ End of Mallet treatment.

Particulars of the bloodformula.

24/5 37 no anisocytosis; no poikilocytosis; no polychromasia; no normoblasts; no toxic granulation or vacuoles; thrombocytes normal.

31/5 no anisocytosis; no poikilocytosis; no polychromasia; no anisochromasia; no normoblasts; no toxic granulation or vacuoles; thrombocytes normal.

7/6 slight anisocytosis; no poikilocytosis; no polychromasia; no normoblasts; no anisochromia; 1 % light toxic granulation; no vacuoles; thrombocytes low normal.

14/6 slight anisocytosis; no poikilocytosis; no polychromasia; slight anisochromasia; no normoblasts; thrombocytes decreased; 1 % vacuoles, 4 % light toxic granulation; MALLET radiation ended.

21/6 distinct anisocytosis; slight poikilocytosis; distinct anisochromasia; no polychromasia; no vacuoles; 9 % light toxic granulation; thrombocytes decreased.

2/7 slight anisocytosis; no poikilocytosis; slight polychromasia; slight anisochromia; no normoblasts; 7 % toxic granulation; no vacuoles; hardly any thrombocytes.

in whom these injuries to the blood gave rise to serious complications, while in two of these patients death was most probably hastened.

History 6918. Female. Age 50. Operated on and postirradiated for mammary cancer with axillary glands in Dec. 1933.

The postoperative irradiation consisted of 3 series in the course of half a year; 4 fields; each field received in total 1800 r. From 24/5 to 9/6 1937 this patient was treated

Table III

History 7430

	↓ 22/7		↑ 3/8	
Date	21/7 '37	27/7	3/8	16/8
Hb. Sahli	103 %	91 %	78 %	64 %
Erythroc.	5.620 mill.	—	—	3.650 mill.
leuc.	5900	5100	1900	1250
eos.	9 1/2	6 1/2	4	3
bas.	1	—	1/2	1
myeloc.	1/2	—	—	—
stab. cells	4 1/2	1 1/2	4	2
polym. nucl.	68	80	66	19
lymphoc.	12	8 1/2	15	72
monoc.	4 1/2	3 1/2	10 1/2	3
supra vital	10 ‰	—	—	—
sedim. rate after 1 and 2 hours.	15/32	—	—	16/

↓ Onset of Mallet treatment.

↑ End of Mallet treatment.

Particulars of the bloodformula.

21/7 37 slight anisocytosis; no poikilocytosis; no polychromasia; slight anisochromia; no normoblasts; no toxic granulation; thrombocytes normal.
27/7 37 aspect of white and red cells normal, thrombocytes normal.
3/8 37 blood platelets low normal; MALLET radiation ended.
16/8 37 red blood no changes.

by Mallet's method for vertebral metastases, after the dorsal vertebrae had first been radiated locally (3000 r divided over 3 fields, Febr., March and May 1937).

By the MALLET method she received in all 715 r, divided over 3 fields, (the upper part of the body from the front and from the back, the lower part only from the front). When the irradiation was discontinued, the patient still had a fair number of leucocytes (see table I). These, however, decreased rapidly in number, so that on 29/6 1937 there were no more than 763 leucocytes per cmm, 2 per cent of which only were polymorphonuclears; thus this was a case of agranulocytosis. Besides, 2 weeks after the end of the radiation, we were struck by the fact that there were hardly any thrombocytes. This was attended with serious haemorrhages of the gums and purpura (first noted 22/6 1937), while the patient also complained of pressure on the stomach (first noted 19/6 1937). Notwithstanding a diet rich in vitamins and pentonucleotide injections there was no improvement. Moreover, the patient got some analgetics (codein, phenacetin, aspirin). After suffering from high fever during the last days of her life the patient died 1/8 1937 with symptoms of haemorrhagic diathesis, gastritis and anaemia.

History 7383. Male, Age 67. Since December 1936 listless; April 1937 painful feeling in throat and chest. End April 1937 swelling of the tonsils. Increasing pain in the chest.

Table IV

History 7431

		↓ 11/5	↑ 15/5	↓ 24/5			↑ 12/6	
Date	30/4 '37	10/5	15/5	22/5	2/6	5/6	12/6	18/6
Hb Sahli	76 %	76 %	88 %	72 %	74 %	74 %	74 %	0 %
erythroc.	4.200 mill.	4.430 mill.	4.530 mill.	4.160 mill.	4.490 mill.	4.120 mill.	4.100 mill.	130 mill.
leuc.	2500	3800	2800	4200	3900	3900	2700	2000
eos.	3	1	1/2	1/2	1/2	1	2	1
bas.	—	—	—	—	—	—	—	—
metamyeloc.	1 1/2	—	—	—	—	—	—	—
stab cells	20	5	8 1/2	9	7 1/2	7	5	5
polym. nucl.	57 1/2	39	52	56 1/2	68 1/2	59 1/2	70 1/2	52 1/2
lymphoc.	3	45 1/2	26 1/2	21 1/2	11	4	14 1/2	25
monoc.	15	9 1/2	12 1/2	12 1/2	12 1/2	28 1/2	8	15 1/2
Türck	—	—	—	—	—	—	—	1/2
thromboc.	—	—	—	—	—	—	—	—
supra vit.								
sed rate after 1 and 2 hours	54 82							
normoblasts on 200 white cells.	—	1						2

↓ Onset of Mallet treatment.

↑ End of Mallet treatment.

Particulars of the bloodformula.

30/4 37 slight poikilocytosis; 15 % toxic granulation; (period of fever 29/4—1/5).

10/5 many pathol. lymphocytes; 15 % toxic granulation; 1 normoblast; normal aspect of the erythrocytes.

15/5 about 10 % toxic granulation, many patholog. lymphocytes; normal aspect of the erythrocytes (subfebrile temperature).

22/5 about 5 % toxic granulation; fairly many patholog. large lymphocytes; red blood: slight anisocytosis (slight elevation of temperature).

2/6 about 10 % toxic granulation, red blood shows some polychromasia; distinct anisocytosis.

5/6 slight toxic granulation; some anisocytosis; slight poikilocytosis; (subfebrile temperature).

12/6 marked toxic granulation; poikilocytosis and anisocytosis; no polychromasia; no normoblasts.

Swelling of the glands bilaterally in the neck and in the groins. Slightly heightened temperature. Coughing. Admitted on 20 May. Both tonsils enlarged, firm and ulcerating. Bilaterally numerous, rather weak, fairly big glands in the neck and the groins. Mediastinum much broadened with enlarged glands in the right hilus. Spleen slightly enlarged. Biopsy pointed to lymphosarcoma. Patient was treated on the Mallet-method from

26/6	3/7	7/7	12/7	19/7	31/7	12/8	23/8	30/8	4/9
55 %	45 %	29 %	31 %	37 %	16 %	—	15 %	16 %	22 %
2.710 mill.	1.880 mill.	1.240 mill.	1 324 mill.	1.040 mill.	630,000	—	1.240 mill.	980,000	1.050 mill.
1100	800	500	400	640	562	1800	1000	1500	1660
1/2	—	—	4	—	—	—	1/2	—	—
—	—	—	—	—	—	—	—	—	—
1	1	bad slide — not differentiated	6	bad slide — not differentiated	bad slide — not differentiated	—	—	—	—
7 1/2	21		7				1	3 1/2	7
47 1/2	31		34			90	64 1/2	75 1/2	67 1/2
35 1/2	35		41			10	28 1/2	10 1/2	21
8	10		8				5 1/2	10	4
—	2		—					1/2	1/2
few	some	more	fairly low	few				76,240	105,000
			19 ‰						100 ‰
		130							
		160							
			1				1		

18/6 polychromasia; poikilocytosis.

26/6 (slight elevation of temperature).

3/7 marked anisocytosis; poikilocytosis; polychromasia; 40 % toxic granulation, a few leucocytes with vacuoles (slight elevation of temperature).

7/7 enormous anisocytosis; some poikilocytosis, relatively many stab cells; vacuoles; not differentiated because of poor number of white cells; evidently more thrombocytes (fairly high fever).

12/7 1 megakaryocyte and 1 normoblast; marked anisocytosis; slight poikilocytosis; slight polychromasia; 40 % toxic granulation (fever).

19/7 and 30/7 (fever).

12/8 Giemsa staining of a thick film. Deplorable blood formula, as far as possible differentiated.

30/8 1 normoblast; although the red blood cells look still very abnormal there are again a proper number of fairly normal looking erythrocytes; anisocytosis; poikilocytosis; polychromasia; toxic granulation (high fever)

4/9 thrombocytes are clearly present again; red blood still shows a marked anisocytosis; polychromasia; marked toxic granulation (fever).

21/5 to 14/6 1937, 4 fields, 475 r in all, while irradiation, too, was applied on 10 small fields (from 100 to 600 r per field), because, in spite of the general irradiation, the glands increased in size and some of the tumors caused troublesome symptoms (sternum, neck, groins, elbow, armpits; together 2800 r). When MALLET irradiation was ceased (the local treatment continued till 26/6 1937) there were yet 2810 leucocytes and a decreased number

of thrombocytes (see table II). A week after the end of the treatment the number of leucocytes had gone down to 885, 55 % of which were polymorphonuclears, while there were hardly any thrombocytes. There also developed a haemorrhagic diathesis (petechiae on the limbs), while the patient expectorated bloody sputa. By auscultation bronchitic and humid rales were found; breath-sounds were weaker on the left, low down on the back, than on the right side. Notwithstanding irradiation the glands had increased rather than decreased. Spleen still enlarged $^{5}/_{7}$ 1937 exitus laetalis.

History 7430. Male. Age 34. June 1935. Glands on the right side of the neck. Disappeared after irradiation. Jan. 1937 recurrence. In spite of irradiation tumors in the armpits and the groins and on the left side of the neck. Only few general symptoms (some perspiring). Oedema of the legs and right arm. Diagnosis: lymphosarcoma generalisata. At the time of admission — for study and treatment — on July 20, 1937, there was generalisation with enormous enlargement of glands bilaterally in the neck, the arm-pits, and the groins, in the abdomen and small basin. Treatment took place by the Mallet-method, from $^{22}/_{7}$ to $^{3}/_{8}$ 1937 the patient received 550 r, divided over 4 fields (upper and lower parts of the body from the front and from the back). At the start of the treatment the patient had 5900 leucocytes (v. table III), on $^{27}/_{7}$ 5,100, on $^{3}/_{8}$ *1900*, while the number of thrombocytes was estimated as low normal. The treatment was, of course, suspended immediately; in the meantime the glands had decreased slightly. But they soon increased again, while cutaneous tumors appeared on the abdomen. On $^{16}/_{8}$ the number of leucocytes had gone down to 1250, 19 % of which were polymorphonuclears. The haemoglobin-value had diminished from 103 % to 64 %. There appeared an agranulocytosis. On $^{21}/_{8}$ suddenly high fever; in the right lung dorsally dullness on percussion. The temperature remained very high (40°). $^{24}/_{8}$ exitus laetalis.

History 7341. Male. Age 33. Since June 1936 pain in the right leg varying in intensity. Jan. 1937 patient noticed a tumor testis. Semicastration elsewhere. $^{8}/_{4}$ 1937 admitted for postoperative irradiation. At that time general metastases were found among others a tumor in the right os ileum, accounting for the pain in the right leg and in the vertebral column, causing a transverse lesion of the spinal cord. After local treatment from $^{8}/_{4}$ to $^{10}/_{5}$ of the groins, abdomen, thoracic and lumbar vertebrae, epigastrium, testicle and left underarm (800 r per field) we decided to apply treatment according to MALLET. By way of precaution the upper part of the body only was irradiated, because the rest had already been treated intensively. From $^{11}/_{5}$ to $^{12}/_{6}$ 1937, with some intervals, the front field was irradiated with 525 r, the back with 400 r. At the end of the irradiation (v. table IV) the leucocytes still numbered 2700, but they fell off constantly; on $^{12}/_{7}$ the leucocytes only numbered 400. In the meantime a thrombopenia (severe haemorrhages of the gums and nose, purpura) first noted $^{29}/_{6}$, developed with a very grave anaemia (amount of Hgl went down to 15 %); in the blood film there were only a few erythrocytes recognizable as such.

For a long time the patient got redoxon $^{1}/_{2}$ gram daily ($^{3}/_{7}$—$^{4}/_{8}$ and $^{10}/_{8}$—$^{16}/_{8}$) and pernaemon 2 c.c. intra-muscular ($^{5}/_{7}$—$^{7}/_{8}$ and $^{10}/_{8}$—$^{16}/_{8}$).

From time to time we gave him lactas calcicus orally and calcium gluconate intravenously. The number of leucocytes went up very gradually, followed by the erythrocytes with an increase of the supravital stainable cells. The blood film indicated regeneration. Till the very end the patient had haemorrhages of gums and nose. Simultaneously numerous cutaneous metastases developed, while the focal symptoms, which had at first been reduced under local irradiation, were increasing once more. Patient showed periodically high temperature during some weeks and irregular intermittent fever from $^{20}/_{8}$ till death. Finally he died $^{23}/_{9}$, showing symptoms of bronchopneumonia and pyelonephritis,

in cachectic condition. Mallet-irradiation had failed to bring any improvement; on the contrary a *very dangerous* condition arose as a result of a temporary exhaustion of the blood-forming system.

The post mortems of these 4 patients revealed the following changes as regards the primary disease.

Case 1. — 6918 — L 6082. Condition after left-sided amputation of the mammary gland. Slight lymphogenic ingrowth of a carcinoma solidum into the anterior mediastinum. Many small haematogenous metastases in the lungs. Haematogenous metastasis in the body of the fifth dorsal and third lumbar vertebrae.

Case 2. — 7383 — L 8578. Lymphosarcoma of the mediastinal and tracheobronchial lymph-glands. growing into the wall of the left main bronchus, extending to the retroperitoneal, pelvic and inguinal lymph-glands. Solitary metastasis in the spleen.

Case 3. — 7430 — L 8797. Lymphosarcoma of the lymph-glands of neck, armpits and groin, with diffuse extension into the retroperitoneal tissue of the left-hand side. Small solitary metastasis in the left kidney and in the liver.

Case 4. — 7341 — L 8848. Condition after leftsided semi-castration because of seminoma testis. Lymphogenic metastasis in the small pelvis and retroperitoneal tissue, reaching as far as the endothoracic fascia; passing from the latter on to the pleura of both lungs. Extensive haematogenic metastasis in kidneys, liver, pancreas, submucosa of the stomach, vertebrae, ribs, skin and right testis.

In the first 3 patients lesions of the haemopoietic organs were found, which have to be ascribed to the irradiation. Because of the similarity of the findings in these three cases, they will be discussed together.

Externally, pallor of the skin was noted in the first case only, the internal organs showing but slight anaemia. There was also a clear haemorrhagic diathesis of the skin, whereas in the other two cases we only noticed some small haemorrhages in and under the skin at different places of the body. In the inner organs the haemorrhagic diathesis was limited to petechiae of the mucous membrane of the stomach in all three cases and besides to superficial haemorrhage in the vesical mucosa in case 3 only.

Once the spleen was too small (120 gr.) and twice moderately enlarged (300 and 320 gr.), in all cases rather soft. On cross-section it showed a brownish-purple colour. But little pulpa could be wiped from the cut surface. In each case the liver showed cloudy swelling, twice fatty degeneration. The bone marrow of the vertebrae was greyishpurple.

Microscopical examination immediately revealed the striking and severe siderosis of the spleen. The small follicles were free from iron. In the Kupfer cells of the liver there was hardly any iron. Siderosis of the bone marrow was also slight. The pulpa of the spleen contained a smaller or larger number of cells owing to the presence of macrophages,

laden with iron. Outside these cells grains and also larger deposits of ferreous pigment were found. Plasma cells were present, in two cases even in great number. Case 2 showed slight erythropoiesis in the splenic pulpa.

The condition of the bone marrow was of paramount importance. Microscopically it appeared that erythropoiesis as well as myelopoiesis had suffered severely. In case 1 there remained but a few strips of erythropoietic tissue among the fat cells; in the two other cases larger areas were easily found. In the first patient myelopoiesis was almost completely absent, plasma cells forming the majority of the white elements. In the other two cases there were small groups of large cells of the myeloid type, with basophilic cytoplasma, some of which showed slight neutrophilic granulation on staining with Jenner's method. A few polymorphonuclears and also some eosinophilic cells could be detected. In case 1 megakaryocytes were completely absent, in the other two cases they were found and were often lying close to the areas of myelopoiesis. In those parts of the bone-marrow in which cells were very scarce, an albuminous oedema was found among the fat cells. In it plasma cells and macrophages occurred, the latter sometimes showing phagocytosis of red blood corpuscles and small amounts of iron pigment. Small heaps of Gram-positive cocci were found in case 3 only.

Severe inflammatory lesions proceeding in the almost entire absence of polymorphonuclears must be looked upon as the immediate cause of death in these patients. Pneumonia, partly haemorrhagic was found twice. In the oedema in the lungs, large numbers of Gram-positive diplococci, streptococci and staphylococci were found, polymorphonuclears and fibrin being practically entirely absent. In case 1 an extraordinary inflammatory condition of the stomach existed. The latter was expanded and filled with a dirty brown-greenish fluid, in which yellowbrown flakes from 1—3 cms in size floated. The stomach wall in the fundus was 1 c. m. thick, owing to marked oedema of the submucosa. Near the pylorus this condition ceased abruptly. A small part of the stomach close to the cardia was equally free from oedema. Along the lesser curvature there were a few petechiae. A flaky yellow-brownish coating had partly come off and was floating in the contents of the stomach. The remainder was lying on the longitudinal folds of the mucosa. Microscopically this coating consisted of a mixture of various micro-organisms! The mucosa itself was unimpaired, the epithelium being actually recognizable under the coating. A great many long, Gram-negative threads were found in the oedema of the submucosa but neither polymorphonuclears nor fibrin.

Summarizing our findings in these three cases, they come down to a severe injury of the myelopoiesis, so that inflammatory conditions

proceed without collaboration of granulocytes (agranulocytosis). Once the bone-marrow showed not only complete absence of myelopoiesis, but also practically complete absence of myeloblasts. In the other two cases the number of myeloblasts had considerably diminished but nevertheless it was much larger than in the first case. Some slightly granulated cells and only very few polymorphonuclears were found. This means that complete ripening of cells is hardly present, myelopoiesis generally coming to a standstill at a very early stage: one could indeed tentatively speak of anakmesis (DARLING, PARKER, JACKSON).[1]

As on microscopical examination there did not seem to be any abnormalities of the erythropoietic tissue (even in case 1 some of the latter was present), it may be assumed that erythropoiesis is not qualitatively injured. The enormous siderosis in the spleen does however point to a severe haemolysis as a complicating condition. On the other hand the findings on the megakaryocytes are again in accordance with those on the granulocytes. They seem to be injured, too, by irradiation.

Case 4 of a patient dying while clinically in a period of regeneration of the white bloodcells, stands apart from the other cases. The immediate cause of death here was an acute pyelonephritis. The pyela of the kidneys were largely distended in consequence of narrowing of the ureters by retroperitoneal extension of the tumor and they were severely inflamed. Microscopically the kidneys showed an ordinary purulent inflammation, abounding in polymorphonuclears. The bone-marrow, apart from the metastases, showed relatively small foci of erythropoiesis and large areas of myelopoiesis. In the latter large cells with neutrophilic and eosinophilic granulation (Jenner stain) were prevalent. Compared with the other cases there were a good many polymorphonuclears. As in these cases, a very severe siderosis was found in the spleen.

The pathological examination of our cases shows that the X-ray treatment according to MALLET may give rise to a very serious and dangerous condition, in that it may cause agranulocytosis and injury to the megakaryocytes.

Anatomically, apart from agranulocytosis, haemolysis is a distinct feature of the fatal cases. The siderotic condition of the spleen points to a process of rather long standing. It does not seem improbable that in some cases while the effect of this treatment is followed with clinical and laboratory methods, this haemolysis may show the dangers of the treatment at an earlier stage than the simple count of the granulocytes.

[1] Am. Journ. Path., Vol. XII, p. 1.

SUMMARY

The clinical course in the four described cases as well as the post mortem examination shows that irradiation of the whole body may cause severe damage to the bone-marrow and the peripheral blood.

In the described cases focal irradiations were applied as well, which may have partly injured the bone-marrow. However, the principal cause of the complications as regards the blood has to be ascribed to the general irradiation, since we never meet with such dangerous conditions in local roentgen treatment.

The myeloid system as well as thrombocytic system appeared to have suffered seriously, while clinically the anaemia and pathologically the siderosis of the spleen indicate that the red blood is injured too (haemolysis).

From our experience we may conclude that, in applying general irradiation, weekly counts of leucocytes and erythrocytes are not sufficient; we must make more frequent and more elaborate examinations of the blood, in which inter alia attention has to be paid to the number of thrombocytes and to the destruction of the red blood, as appears from the increased bilirubin content of the serum, the increased amount of the urobilin in the urine and the increased number of vital stainable erythrocytes as a reaction to this destruction. With these precautions general Roentgen irradiation (Mallet's method) may be applied in special cases in which other therapy is not suitable.

ZUSAMMENFASSUNG

Der klinische Verlauf der beschriebenen Fälle und auch die Autopsien zeigen, dass Bestrahlung des ganzen Körpers eine ernstliche Schädigung des Knochenmarkes und des peripheren Blutes verursachen kann.

Wohl waren die beschriebenen Fälle auch lokal bestrahlt wodurch das Knochenmark schon geschädigt gewesen sein kann, aber als die Hauptursache der Komplikationen seitens des Blutes muss die allgemeine Bestrahlung angesehen werden, da wir niemals solche gefährlichen Zustände bei lokaler Röntgentherapie finden.

Das myeloide System sowie das Thrombocytensystem haben ernsten Schaden gelitten, während klinisch die Anämie und pathologisch-anatomisch die Siderosis der Milz auf eine Schädigung des roten Blutes hindeuten (Hämolyse).

Aus unserer Erfahrung kann man schliessen, dass, wenn man allgemeine Bestrahlung anwendet, ein wöchentliches Zählen der Leukocyten und Erythrocyten nicht genügt. Man muss öftere und ausführlichere Blutuntersuchungen vornehmen, wobei u. a. auf die Zahl der Thrombocyten und den Abbau des roten Blutes, merkbar durch die Zunahme des Bilirubingehaltes im Serum, des Urobilingehaltes im Urin und durch die Anzahl der vital färbbaren Erythrocyten, geachtet werden muss. Mit diesen Vorsichtsmassregeln darf allgemeine Bestrahlung nach MALLET in bestimmten Fällen, bei denen andere Therapie nicht im Frage kommt, angewandt werden.

RÉSUMÉ

Le cours de la maladie dans les quatre cas décrits ainsi que les autopsies démontrent que l'irradiation de tout le corps peut causer des altérations délétères de la moëlle et du sang périphérique.

Dans ces cas, on avait bien appliqué aussi le traitement local, qui peut être retenu comme cause accessoire de ces altérations de la moëlle, mais nous estimons que la cause

principale en est l'irradiation générale, étant donné que jamais nous n'avons constaté de complications si graves après irradiations locales.

On constate de graves troubles tant dans le système myéloïde que dans le système thrombocytaire, tandis que cliniquement l'anémie, et pathologiquement et anatomiquement la sidérosis de la rate indiquent que le sang rouge est lui aussi avarié (haemolysis).

L'expérience nous a démontré que dans l'irradiation générale, le calcul hebdomadaire des leucocytes et des érythrocytes n'est pas suffisant. On doit examiner le sang plus souvent et plus minutieusement, et il faut faire attention au nombre de thrombocytes et à la détérioration du sang rouge, qui se trahit par l'augmentation de la teneur du sérum en bilirubine et de la teneur de l'urine en urobiline, et par le nombre de réticulocytes.

En prenant ces précautions, on pourra appliquer l'irradiation Rœntgen générale (méthode MALLET) dans des cas déterminés, auxquels on ne pourrait appliquer aucun autre traitement.

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CHIEF: ÅKE ÅKERLUND, M. D.

A CHARACTERISTIC DUODENAL DEFORMITY IN CASES OF DIFFERENT KINDS OF PERI-VATERIAL ENLARGEMENT OF THE PANCREAS[1]

by

Nils Frostberg

At the roentgen departments of Maria and Red Cross Hospitals in Stockholm three cases have occurred in recent years of a similar and peculiar deformity of the duodenum. In all the cases some affection of the pancreas was considered likely. As the patients subsequently died and the autopsic findings were found to some extent to differ from what one was led to expect from the roentgenograms, the cases are considered worthy of being recorded.

Case I. Male, aged 55. Consulted the surgical out-patient dep. for pains under the right costal arch on deep breathing and coughing. These complaints had lasted 4—6 months. A feeling of fulness in the abdomen had recently been added and as icterus also supervened patient was admitted for examination. The findings included a large liver, reaching to 4 finger-breadths below the costal arch, pale stools and a stout-coloured urine. Weber's test in faeces came out positive, Meulengracht's in blood 1: 60. On roentgen examination of stomach and duodenum June 11 1937 there were no organic changes to be seen. On renewed examination one month later the duodenal loop showed normal breadth but in several pictures taken in prone position there could be seen two superimposed depressions at the concave contour of the descending part of duodenum as if caused by some pressure. The seat of junction of these two concave contours was not pointed but more rounded and bud-shaped which made one suspect the possibility of a crater. In addition there was a clearly elongated irregular defect in the very lumen of the duodenum. The roentgen appearance was considered indicative of some tumour of the head of pancreas. The stomach emptied in a normal manner (fig. 1). Cholecystoduodenostomy was performed but the patient did not survive the operation. On autopsy (WAHLGREN) was found »just above the Vateri papilla a rounded ulceration in the duodenal wall about the size of a penny. The floor of the ulceration was necrotic and drawn out in a fairly well marked tent-like fashion. Walls were somewhat swollen, hard and fibrous. Papilla Vateri seemed somewhat swollen from oedema and

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caused some bulging into the intestinal lumen... In the head of pancreas was discovered around the above-mentioned ulceration and the lower part of the common bile duct a hard tumorous infiltration. Otherwise nothing abnormal in the pancreas ... Lower down in the right liver lobe there was a secondary deposit, the size of a hen-egg, and scattered in the liver there were grey-white secondary deposits, the size of up to hazel-nuts ...» (fig. 2.) *P. A. D.* Carcinoma of head of pancreas, secondary deposits in liver, generalised icterus and postoperative conditions.

Fig. 1.

Case II. Female, aged 47, who had been under treatment at Maria Hospital (med. section) for several periods in 1934 and 1935. In the early part of October 1934 she began to develop a yellow complexion. Itching arose and stools became pale. On palpating the abdomen there was a certain amount of rigidity in the epigastrium but the liver could not be definitely felt. Meulengracht 1: 65. Bromide sulphalein test 60 %. Takata neg. Rona's test 5—6 drops. Weber's test in faeces neg. Patient got slowly worse and lost weight. Liver increased in size and Weber's test in faeces became positive. Clinically suspicions were directed towards cancer of the Vateri papilla. On roentgen examination Jan. 9 1935 normal conditions were found in stomach and duodenal bulb. »The duodenal loop was not wider than normal. In the concave contour of the descending part of the duodenum there are two flattened rounded depressions located above one another. These give cause for assuming a nodulous state of the pancreatic head, which in its turn leads to the suspicion of tumour. However, the duodenal wall appears to be soft even in this region and the mucous membrane relief is arranged in a normal manner wherefore there is nothing to indicate infiltration of the duodenal wall; the roentgen appearance must therefore be ascribed to some pressure effect from the head of pancreas» (fig. 3.). But for solitary periods of improvement patient's condition grew from bad to worse. Repeated copious intestinal haemorrhage. Ascites. Died Sept. 18, 1935. Autopsic findings (WAHLGREN): »A brown-red discoloured tumour about the size of a cherry at papilla Vateri; its surface was to some extent split asunder and the tumour protruded wholly into the lumen of the duodenum. It entirely occluded the common bileduct as well as the pancreatic duct ... All the bileducts were markedly dilated and contained a colourless fluid ... Considerable oedema in the retroperitoneal tissue around the head of pancreas and in the mesenteric root. Pancreas was smaller than normal and of firm consistence. The cut section was grey-white and oedematous. The pancreatic duct had the thickness of a lead pencil and contained a clear colourless fluid ...»

P. A. D. Carcinoma of papilla Vateri, biliary cirrhosis of liver, haemorrhagic ascites, marasmus (fig. 4).

Case III. Male, aged 61, who since October 1937 had complained of indefinite abdominal discomforts and heartburn. Icterus began to appear at the end of November.

Fig. 2.
1. Pylorus. 2. Papilla Vateri. 3. Crater.

Subsequently itching and emaciation. In the middle of December he was admitted to the Red Cross Hospital for examination. On roentgen examination (ÅKERLUND) Dec. 18 1937 an abnormal depression was found on the lesser curvature of the stomach, most marked just above angulus ... »The duodenal loop presented on its concave side a definite depression pointing to enlargement and above all to an increase consistence of the pancreas. The appearance of the mucous membrane relief on several of the duodenal pictures is against any direct encroachment upon the duodenum. On account of the large liver it was impossible directly to palpate the pancreas.» A polypous kind of defect, the size of a three-penny bit, was found in the inferior flexure of the duodenum, and in the ascending part of the duodenum there were one or two others of similar appearance but considerably smaller ... »Within the field of projection of the pancreas one could see on several pictures close to the middle part of the ascending portion of duodenum a small triangular dense shadow mostly resembling a concretion in the pancreas.» ... The depression into the duodenum from the concave side was considered due to some process of infiltration in the pancreas. »Whether this could conceivably be of pancreatitic nature (for which to some extent the presence of concretion-like calcifications in the head of pancreas may be evidence in support) or in the nature of a tumour must be left an open question ...» The polypous defects in the duodenum did not seem likely to have any direct bearing on the pancreatic changes (fig. 5). Patient's general condition grew rapidly worse, towards the end intestinal haemorrhage supervened. Operative treatment was deemed out of the question. Patient died on Jan. 4 1938. At the autopsic examination (SCHEELE) was found a liver considerably enlarged presenting

Fig. 3.

Fig. 5.

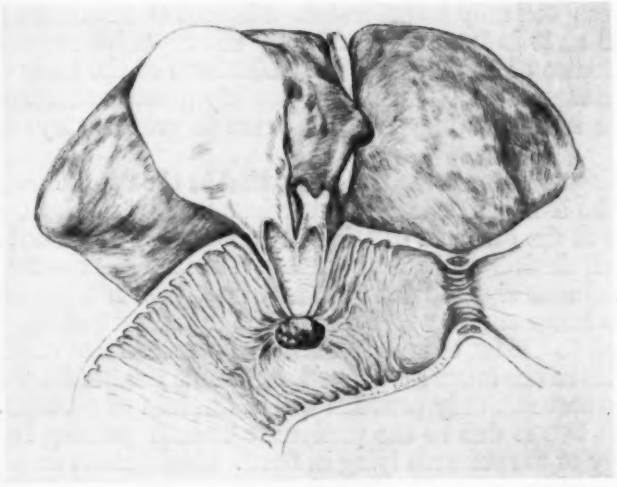

Fig. 4.

the appearance of biliary cirrhosis. The gallbladder contained some 20 angular stones, the size of peas. The hepatic duct and common bileduct were much dilated. The latter was dilated as far as a short distance from the papilla Vateri where it suddenly became narrower, not allowing any probe to pass. The head of pancreas was enlarged to about double its size, was nodular and hard. The pancreatic ducts were not definitely dilated. On section in one or two places no concretions could be seen. The pancreatic structure was in part fairly well maintained. Microscopical examination (FÅHRAEUS). - - »The sections made through the pancreas show wellmarked fibrosis of the organ as well as round-cell infiltration in the coarser strands of connective tissue as signs of pancreatitis. Although the organ shows well advanced cadaverous changes one or two smaller patches of necrosis can be demonstrated. The islands are fairly well maintained but strikingly scanty in the sections.»

As is well known the shadow of the pancreas itself cannot be seen on the *radiogram*. Pneumoperitoneum has not yielded such results as to lead to a systematic use of that method. LYSHOLM and ENGEL in 1934 gave an account of a method by which the pancreas could be revealed by inflating the stomach with carbon dioxide. In some cases where ordinary methods of examination fail to reveal any changes this method has proved of value. ERNST suggests inflation of the transverse colon simultaneously with filling the stomach with some opaque medium. By observing the relative position of these organs useful information can be had regarding the possible presence of pancreatic tumours.

As a rule, however, most attention is paid to such changes in neighbouring organs, stomach, duodenum and colon, which sooner or later will be the result of every change in shape or increase in volume to which the pancreas will may be subjected. Diseases of the head of pancreas, surrounded as it is from three sides by the digestive apparatus, stand the best chance of being diagnosed. Affections of the body or tail, except in the case of concretions (and possibly gaseous abscess), are most difficult to reveal as long as the increase in volume stays within reason.

According to HERNHEISER one may find in the case of tumours (incl. cysts) of the head of pancreas depressions into or displacement of the curvatures of the stomach (usually the lesser one) or central defects in the stomach shadow of extrinsic causes. ASSMAN has several times observed an almost right-angled stomach, mostly with a concave depression of the lesser curvature, giving to the upper part of the stomach a vertical and to the lower part a horisontal course. Most of the contrast then collects in the lower sac-shaped part while the middle vertical portion of the stomach only contains a thin stratum of contrast. ASSMAN thinks that this is due to the pancreatic tumour pressing from behind on the body of the stomach lying in front. HERNHEISER as well as ASSMAN also describe changes in the pyloric part of the stomach which in the presence of tumour of the head of pancreas is drawn out in a horisontal

direction or displaced upwards, then becoming narrower than normal. Compression results in diminished contrast intensity. The differential diagnosis between tumours within and without the stomach (left liver lobe, retroperitoneal tumours, aneurysm, renal growths) is then often difficult, indeed sometimes impossible to settle. In favour of the latter ever we have movability on palpation, peristalsis at the suspected place and alteration in the shape of the stomach in different positions of the body. In the event of the tumour being adherent to the stomach wall it may of course be impossible to settle the differential diagnosis.

As to the duodenum this may present varying pictures. So for instance may the duodenal loop show an increased width without the lumen showing any changes. The duodenal loop — concave to the left — becomes enlarged with the result that the bulb and the pars pylorica get pushed towards the left (SCHINZ). Thus in the main what was mentioned above while discussing changes in the stomach. From this condition we get all kinds of transitions of displacements, deformities and infiltrations of the wall even to the point of more or less marked stenosis. Stenosis generally befalls the duodeno-jejunal flexure. This part is mostly affected on account of its fairly high position, partly fixed by the Treitz muscle from the flexure up towards the diaphragm. The flexure is squeezed between the head and the body of the pancreas and a tightly expanded peritoneum. In DORNER's opinion a slight over-filling and a somewhat retarded emptying of the duodenum should make one suspect an early stenosis of this flexure. This form of stenosis is not however characteristic of cancer alone, but may also occur in indurative pancreatitis. Stenosis of the inferior part of the duodenum with dilatation of the prae-stenotic part of the gut may be due to pressure of the mesenteric root (arterio-mesenteric obstruction). BERNSTEIN has shown that it may also be a question of a functional condition, the causes of which he is investigating. Naturally other parts of the duodenum may also be the seat of stenosis. When the tumour encroaches upon the intestinal lumen the differential diagnosis from primary benign or malignant growths of the duodenum is often rendered difficult.

Now and again carcinomatous pseudo-diverticuli arise in the descending part of the duodenum which, if occurring as the sole trouble, can be more seldom differentiated from true diverticuli (or ulcer nisches). HERNHEISER has described a case of that nature in which it was difficult even for the pathologist to decide which of the two kinds was present since the walls were smooth; subsequently, however, a secondary cancer of the pancreas with the primary focus in the bronchi proved to be the cause. Irregular outlines of the walls on the radiogram are considered in favour of carcinomatous pseudo-diverticuli. SCHINZ has

reproduced a picture of that kind where also the same kind of duodenal deformity was present as in the three cases related above.

Isolated deformities of the duodenal cap without other symptoms of pancreatic growth are also said to occur and are then quite naturally suspected of being secondary to ulcer formation.

Finally we find the colon the seat of changes, particularly in the case of very large tumours of the pancreas. The position of the gland will make the transverse colon the most likely seat. Here, too, we find displacement, as a rule downwards (rarely upwards) and occasionally compression of the lumen or infiltration of the wall.

It is not very usual to find any roentgenological manifestations of pancreatitis since this rarely gives rise to any marked increase in size. If anything is found at all it is generally also here in the nature of displacement and compression as in the case of tumours. It is thus maintained by BRONNER that acute pancreatitis, because of swelling of the whole organ, may cause, among other signs, compression of the duodeno-jejunal flexure which in conjunction with other clinical symptoms may be of diagnostic value in a difficult acute case. Tenderness on pressure and tumefaction at the seat of the pancreas sometimes prove a valuable guide. Some authors believe that some etiological relationship exists between dilatation of the papilla Vateri (diverticulum Vateri) and pancreatitis. So did CASE find pancreatitis on operation of a large number of cases with diverticulum Vateri. In a case of ampulla Vateri ÅKERLUND has found necrosis of the pancreas and closely discussed the relationship. He points out that the filling of a dilated ampulla Vateri on the radiogram must be regarded as a valuable indication of the likelihood of chronic pancreatitis and should encourage special clinical examinations to be made of the pancreatic function.

In reviewing the above mentioned radiograms and the autopsic findings we find that cancer of the pancreas is only present in case 1. The ulceration, about the size of a penny found at the autopsy, was not likely to have reached any greater depth at the time of examination as it had then probably been more readily revealed. There was an interval of 14 days between the roentgen examination and death. As already mentioned SCHINZ has quoted a case of that nature. Deformity of the duodenum of a similar type has been described by GUTMAN and JAHIEL in a woman, aged 24, who was found to have a sarcoma of the pancreas.

The most surprising thing in case 2 was that no defect had been seen in the duodenal contrast as a result of the papilla Vateri tumour, as large as a nut. Here, too, a fairly long time had passed between examination and death, in fact more than 8 months. During this period there had also been repeated large intestinal haemorrhages which are

indicative of the tumour increasing in size. It would seem, therefore, that this had been too small at the time of examination to produce any visible defect on the radiogram. In 4 cases of periampullar duodenal carcinoma MATEER and HARTMAN were only able in one of them to show a defect in the contrast in addition to some retention of the contrast on the proximal side of the filling defect. ASSMAN points out that cancer in this region is as a rule productive of flattened ulcerations and therefore evades diagnosis. Moreover the transient filling of the descending portion of the duodenum does not lend itself very well for getting a record of a defect. According to ASSMAN they are more often revealed indirectly after their encroachment on the pancreas and subsequent compression of the duodeno-jejunal flexure. The deformity of the concave side of the duodenum in the above mentioned case was not caused by such intrusion on the part of the tumour which perhaps one would have had reason to expect. The autopsic examination gave no evidence of that nature. The tumour had probably at first by traction on this region formed the intestinal wall into a spout. To this was added swelling of the pancreas through stagnation of secretion with further development of the deformity.

In case III a chronic pancreatitis was found to be the cause of the duodenal deformity which here was more pronounced than in the other cases. No diverticuli could be found but the presence of a concretion in the pancreas made one consider also the possibility of pancreatitis in the discussion of the causation of the deformity although tumour was regarded the most likely.

The changes described here are not therefore typical of any particular disease of the head of the pancreas but may occur both in the case of tumour and pancreatitis (and possibly also in simple oedema) but are nevertheless of interest. As already mentioned similar signs have been recorded earlier and are probably not uncommon. It should be remembered, however, that a similar appearance of a normal duodenal loop will be found in TESCHENDORF's table of the various courses the duodenum may assume. The normal concave outline of the duodenum does not present the obvious appearance of pressure effect as in the cases described. We have been unable to ascertain what is at the bottom of this peculiar deformity. The stopper-like protrusion to the left would seem to be located in the region of the papilla Vateri. Whether this part of the wall is kept fixed by the pancreatic duct and the common bile duct with the surrounding glandular tissue extending beyond the fixation in a ridgelike manner will be left an open question.

SUMMARY

The author is recording three cases of a similar and peculiar deformity of the descending part of the duodenum assuming the shape of an inverted figure »3». On the strength of radiographic examination growths in the caput pancreatis were considered the most probable explanation but autopsic findings have shown that pancreatitis and oedema may also give rise to such deformities.

ZUSAMMENFASSUNG

Verf. berichtet über drei Fälle, bei welchen die konkave Kontur der Pars descendens duodeni eine eigenartige — bei allen drei einander ähnliche — Deformierung in der Form einer umgewendeten 3 aufwies. Auf Grund der Röntgenbilder wurden Tumoren im Caput pancreatis für das wahrscheinlichste gehalten, die Sektionsbefunde zeigten aber, dass auch Pankreatitis und Ödem eine ähnliche Deformierung geben können.

RÉSUMÉ

L'auteur rend compte de trois cas d'une curieuse déformation similaire du contour concave de la pars descendens duodeni, adoptant la forme d'un 3 retourné. En se basant sur les clichés roentgen, on a considéré des tumeurs dans le caput pancreatis comme étant le plus probable, mais les constatations lors des autopsies ont démontré que la pancréatite et l'œdème peuvent également provoquer une semblable déformation.

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FROM THE PHYSICS DEPARTMENT OF KING GUSTAF V. JUBILEE CLINIC, STOCKHOLM
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FIVE YEARS' EXPERIENCE OF MODERN SHOCK-PROOF AND RAY-PROOF CONTAINERS FOR ROENTGEN THERAPY TUBES[1]

by

R. Thoræus

The introduction of shock-proof and ray-proof enclosures for roentgen therapy tubes and their high-voltage connections undoubtedly involves so many great advantages that it may be designated a considerable improvement of the technique of both the medical radiology and other scientific branches in which high-voltage roentgen rays are habitually employed. The use of a roentgen unit is thereby rendered as safe as possible, and is furthermore both facilitated and simplyfied.

In recent years, however, a purely financial point has been brought into the discussion on the use of protective enclosure for therapy tubes, viz. the life of the tube in relation to its price, or in other words the tube cost per hour of operation. This point is directly connected with the fact that the types of tubes used in protective enclosures are more expensive than the majority of the tubes previously used without such enclosures. The answer to this question, however, necessarily requires extensive knowledge of operating results. The intimate collaboration between the Swedish roentgen therapy departments, administered by specially trained radiologists, and the Radiumhemmet Physics Department puts us in the favourable position of having in our hands all the experience gained in this country. This extensive experience may be considered especially reliable, since the operating conditions of all the tubes used are very uniform, and physically and technically checked by direct measurements twice a year.

The modern protective containers at present used in Sweden are of three different makes, viz. Järnh, Siemens and Philips. The Järnh container is a purely Swedish product, whereas the others are foreign.

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The Järnh and Siemens units are provided with oil-cooling systems for the roentgen tube, while the Philips unit has a water-cooling system. The Siemens and Philips containers are exclusively designed to be used with the types of tubes made by the respective manufacturers, and can consequently not be used with other types. The Järnh container, on the other hand, is intentionally so designed that roentgen tubes of different makes can easily be used interchangeably. As far as is known, it is furthermore the only container the construction of which permits not only direct measurements of the milliamperage and tube voltage immediately at the roentgen tube terminals but also very easy access to the tube itself, whereby the procedure of inserting, removing, or inspecting the roentgen tube is very much facilitated and simplified. Other features of the Järnh container that have proved favourable are the automatic ventilation of the treatment room, and easily handled screw gears for the convenient adjustment of the container to its proper position in relation to the patient.

Electrically, all the abovementioned containers are calculated to stand a tube voltage of 200 kV constant potential, the usual maximum rating of ordinary therapy tubes. A convenient margin has been obtained, however, by not using tube voltages above 180 kV constant potential. All the protective containers installed have proved reliable and convenient in operation. In some of the very early ones there had been some difficulty in obtaining absolutely tight tubing connections for the cooling medium. This has now been long overcome.

Table 1.

At the end of the year	Total number of therapy units in Sweden	Number of modern protective containers in operation			
		in all	Siemens make	Järnh make	Philips make
1932	64	1	1	—	—
1933	62	2	2	—	—
1934	64	3	2	1	—
1935	64	11	6	5	—
1936	66	16	9	7	—
1937	73	32	12	19	1

Table 1 illustrates the introduction of modern protective containers for roentgen therapy tubes in Sweden. At the end of 1937, 44 per cent of the total number of therapy units were equipped with such containers. From the figures in the table it will be seen that the progress has been very rapid in the last three years. From the point of view of providing the best possible protection for both patients and working staff, it would

seem desirable to have the remaining old equipment replaced by modern protective containers as soon as possible. For practical reasons, however, the accomplishment of this desideratum seems likely to take at least another two or three years. As far as is known 9 protective containers were ordered by the end of 1937, and will be installed during 1938. This means that more than 50 per cent of the total number of therapy units will be equipped with modern protective containers within the first three or four months of 1938. The first container installed in 1932 is operated with a Villard high-voltage generator, the others with Greinacher generators.

In Sweden, and probably in most countries, the majority of the roentgen therapy departments have only one unit for all the required roentgen treatments. As pointed out by the author on a former occasion this fact necessitates the use of roentgen tubes with relatively thin glass walls or windows. When the first Swedish-made shock-proof and ray-proof container for roentgen therapy tubes was installed in 1934 (*Acta Radiol.* Vol. XVIII, 1937, p. 236), the A. E. G. tube type EWT 200 was practically the only oil-cooled tube suitable for protective enclosure, the properties of which simultaneously agreed with the above condition. This type of tube was therefore used in the first Swedish-made protective containers. Since 1935, however, Siemens Doglas tubes, at my request provided with thin glass walls, are available in Sweden and used in the

Table 2.

Operating results at constant potential with A.E.G. tubes Type EWT 200 in Järnh containers.

Tube No	Date of operation	Tube life in hours[1]
1395	$^{6}/_{11}$ 35—$^{30}/_{10}$ 36	412
1397	$^{1}/_{8}$ 35—$^{31}/_{12}$ 37	(1 458)
1406	$^{17}/_{11}$ 34—$^{24}/_{1}$ 36	176
1415	$^{22}/_{10}$ 35— $^{7}/_{4}$ 36	135
1416	$^{8}/_{12}$ 35— $^{4}/_{3}$ 37	817
1421	$^{27}/_{1}$ 36— $^{4}/_{3}$ 36	25
1428	$^{24}/_{1}$ 36—$^{10}/_{3}$ 36	33
1434	$^{24}/_{2}$ 36—$^{28}/_{4}$ 36	15
1435	$^{5}/_{3}$ 36— $^{7}/_{5}$ 36	27
1436	$^{17}/_{3}$ 36— $^{9}/_{12}$ 36	772
1437	$^{18}/_{3}$ 36—$^{18}/_{3}$ 36	4
1439	$^{9}/_{4}$ 36— $^{2}/_{11}$ 36	188

[1] Figures in brackets indicate that the tube was in operation on $^{31}/_{12}$ 1937.

Siemens containers. Involving more technical improvements than the EWT 200 tubes, the thin-walled Doglas tubes are at present also accepted as standard equipment for the Swedish-made protective container. In accordance with the demand of the author, discussed in a previous article (*Acta Radiol.* Vol. XVIII, 1936, p. 161), each Doglas tube delivered in Sweden is accompanied by information on the equivalent, in mm of aluminium, of the tube glass-wall. To illustrate this it may be mentioned that the thin-walled Doglas tubes at present used in Sweden have tube-wall equivalents of 1.0—1.2 mm aluminium.

Table 2 gives the operating results obtained with tubes of type EWT 200 in Järnh containers. All these tubes have been operated at practically the same rating. It is, however, interesting to note that the tubes 1421, 1428, 1434, 1435 and 1437 have failed after very brief periods of operation. They may be considered to have been of faulty manufacture. Except for these five tubes — and No 1397, which is still in operation in the Radiumhemmet therapy department — we calculate an average life of 417 hours for the remaining tubes.

Table 3 gives in the same way the operating results obtained with the Siemens Doglas tubes. All these tubes have been operated at practically the same ratings, viz:

1 Al, 100—110 kV, 3—4 mA
4 Al, 140—150 kV, 4 mA
0.5 Cu + 1 Al, 165—175 kV, 6—7 mA
Tin-filter, 165—175 kV, 6—7 mA.

Since the Siemens container was the first introduced, the operating results obtained with it are more extensive. The table shows that final results are available for eleven tubes, and on the basis of these results an average tube life of 609 hours is calculated. (Tubes that do not last 50 hours are considered to be faulty, and are not included in the calculations.) It will also be seen that of all the tubes only one, No 20014, has lasted more than one thousand hours. It is, however, of interest to note that the number of this tube is quite different from the numbers of the others, thus indicating that it belongs to another series of manufacture. The question of how far this fact may be connected with the great difference in the operating results can, of course, only be answered by the manufacturer, who knows the significance of the numbers.

The first Doglas tube operated in a Järnh container is No 35477. By the end of 1937, the operating result with this tube was very nearly one thousand hours. The tubes 35538 and 35548 have both passed 1100 hours, and are still in operation. The tube No 35618 was discarded because of leakage in its oil tubing connections, and No 35523 because of failing vacuum.

Table 3.

Operating results at constant potential with Siemens Doglas tubes Type DEW 200/6

In Järnh containers			In Siemens containers		
Tube No	Date of operation	Tube life in hours[1]	Tube No	Date of operation	Tube life in hours[1]
35268 . . .	8/5 36—17/5 37	350	20014 . . .	10/11 33—31/9 37	2 322
35477 . . .	30/4 36—31/12 37	(987)	35179 . . .	5/7 33— 9/9 33	150
35512 . . .	20/11 36—31/12 37	(522)	35184 . . .	23/9 33— 4/11 33	108
35521 . . .	5/5 37—31/12 37	(215	35186 . . .	9/9 33—31/9 33	35
35523 . . .	17/11 36—17/11 36	0	35242 . . .	18/1 35—13/7 36	515
35538 . . .	4/11 36—31/12 37	(1 123)	35315 . . .	15/5 35—27/10 36	134
35546 . . .	11/5 37—31/12 37	(206)	35335 . . .	21/1 36—28/4 36	90
35545 . . .	16/6 37—31/12 37	(64)	35336 . . .	13/7 36—31/12 37	(778)
35548 . . .	10/12 36—31/12 37	(1 133)	35337 . . .	28/5 37—30/9 37	(239)[2]
35549 . . .	1/9 37—31/12 37	(217)	35397 . . .	23/6 35—31/12 37	(732)
35618 . . .	19/6 37—29/6 37	13	35415 . . .	12/11 35—19/5 36	345
35621 . . .	18/8 37—31/12 37	(112)	35482 . . .	20/5 36—24/5 37	627
35622 . . .	4/10 37—31/12 37	(117)	35483 . . .	29/4 36— 6/7 37	708
35626 . . .	28/5 37—31/12 37	(568)	35485 . . .	26/2 36—14/12 37	553
35628 . . .	4/10 37—31/12 37	(116)	35518 . . .	28/4 36—15/6 37	740
35631 . . .	15/10 37—31/12 37	(175)	35528 . . .	13/4 37—31/12 37	(246)
35655 . . .	18/9 37—31/12 37	(42)	35529 . . .	30/10 36—31/12 37	(309)
35677 . . .	23/11 37—31/12 37	(1)	35530 . . .	9/7 37—25/11 37	(300)[2]
35679 . . .	4/10 37—31/12 37	(126)	35542 . . .	8/9 37—31/12 37	(403)
35680 . . .	4/10 37—31/12 37	(113)	35620 . . .	4/10 37—31/12 37	(134)
35703 . . .	30/10 37—31/12 37	(42)	35625 . . .	15/6 37—31/12 37	(271)
			35630 . . .	4/10 37—31/12 37	(126)
			35705 . . .	26/11 37—31/12 37	(33)
			35710 . . .	15/12 37—31/12 37	(12)

[1] Figures in brackets indicate that the tube was in operation on 31/12 1937.
[2] Spare tubes.

From the beginning of 1936 Doglas tubes have been used in both the Järnh and the Siemens containers. The following is a summary of the operating results of all the tubes inserted in 1936:

In Järnh containers	In Siemens containers
350	90
(987)	(778)
(522)	627
(1 123)	708
(1 133)	553
	740
	(309)
average 823 hours	average 544 hours

The average value 544 hours is about 10 per cent smaller than the 609 hours obtained above on the basis of eleven final results.

The five Doglas tubes 35315, 35335, 35482, 35483 and 35518, all of them operated in Siemens containers, have failed in the following way. After some time of operation the intensity suddenly began to decrease and fell, within a relatively short period, to much less than 50 per cent of its initial value, without any noticeable changes in the operating conditions. On the basis of actual experience of other tubes of similar anode construction, the author is inclined to believe that the failure of these tubes was in all probability due to insufficient cooling. The maximum tube rating used was very nearly the same for all the Doglas tubes, and all were cooled with oil supplied by the tube manufacturer. The only difference is that the oil flow in the tubes cooled by Siemens pumps is 6 litres per minute, whereas in those cooled by Järnh pumps it is 15—17 litres per minute. The anode type used in the Doglas tubes requires very effective cooling. If insufficiently cooled, the tungsten disc embedded in the copper body of the anode (*Acta Radiol.* Vol. XVIII, 1937, p. 862) will overheat, and probably separate from the heat-dissipating body, more or less covering the anode window, the result being that the beam will be correspondingly screened off and the intensity output considerably decreased. The irregular occurrence of this phenomenon necessitates rather frequent checking of the intensity output. Recently a Doglas tube, in which the abovementioned phenomenon occurred, was opened and the anode dismounted. It was then found that the tungsten disc had completely separated from the copper body and partly covered the anode window. This finding directly confirms the above assumption. The Siemens containers in Sweden are therefore successively provided with oil pumps of greater capacity, and for this purpose Järnh pumps (*Acta Radiol.* Vol. XVIII, 1937, p. 865) have been employed.

In cases where high-grade filtration or very long focus — skin distances are used, the intensity is considerably reduced, and it would then be favourable to have the possibility of increasing the intensity by raising the milliamperage above the normal value, six or seven mA. Quite recently the Siemens Reiniger Werke has introduced a heavy-discharge type of oil-cooled Doglas tube, the maximum rating of which is 15 mA at 200 kV constant potential. At this rating an oil flow of at least 15 litres per minute is required for cooling. This type of tube can be directly inserted in the Swedish-made shock-proof and ray-proof container described by the author (*Acta Radiol.* Vol. XVIII, 1937, p. 236), since the oil pump used is of the requisite capacity. Such a tube has actually been used in the Radiumhemmet therapy department for a period of about twelve months. The high milliamperages, however, are only combined with heavy filters or great focal distances in order to reduce

the treatment times. For the normal tin-filter, 12 mA has, for instance, been selected. The operating results with this new tube have hitherto been quite satisfactory; no interruptions or disturbances have occurred. In the abovementioned period of about twelve months the tube was in operation for 408 hours.

From table 1 it will be seen that one Philips unit is in operation. At the end of 1937, this unit had only been in operation for about six months, which may be considered too short a period for any reliable conclusions.

In discussing the economy of the tubes used in protective containers, the operating results obtained with previously employed tubes must be used as a basis. For more than eleven years A. E. G. T III air-cooled tubes have been used by most Swedish roentgen therapy departments. Consequently our experience of this tube is rather extensive, and may be considered very reliable, since these tubes have been operated under very uniform conditions and have been physically and technically checked by direct measurements twice a year. We have, in fact, no less than 141 T III tubes that have been used for all kinds of ordinary roentgen therapy, under very similar operating conditions and at constant potential. On the basis of the operating results of all these tubes we calculate an *average tube life of 408 hours for the T III tube.* The price of such a tube is 1320 Swedish kronor, which means an average tube cost of 3.24 kronor per hour of operation.

The radiating power of different tubes, i. e. their intensity output under identical operating conditions is a very essential factor, however, which must be taken into account when discussing the economy of the tubes. Direct measurements by the author have actually shown that at 100, 150 and 170 kV constant potential the free-air intensity output of a thin-walled Doglas tube is 10, 14 and 16 per cent respectively smaller than from a T III tube, or in other words that the radiating power of the Doglas tube is on an average 13 per cent less than that of the T III tube. The tube cost per hour of operation may accordingly be estimated at $0.87 \times 3.24 = 2.82$ kronor. The present price of the Doglas tube is 2 100: — kronor which directly gives a minimum life of $\frac{2\,100}{2.82} = 745$ hours.

In Sweden, however, we commonly select the operating conditions, milliamperage, and tube-voltage, of the Doglas tubes so as to get about the same intensity output as with the T III tube and its rather standardised operating conditions. In such cases we may thus consider the Doglas tube as efficacious as the T III tube, and consequently calculate with a tube cost of 3.24 kronor per hour of operation. This gives a minimum life of 650 hours.

In the discussion of the economy of the protective enclosure of the therapy tubes, however, the cost of the container, stand, cables, pump and other accessories of the unit should also be taken into consideration. This cost amounts at present to about 8 000: — kronor. To get a reasonable amortisation of this cost, the life of the tube must exceed the minimum value calculated above.

If we designate

A = Amortisation per year
P = price of the tube
T = life of the tube in hours
N = hours of operation per year
C = tube cost per hour of operation

we get

$$A = N\left[C - \frac{P}{T}\right];$$

It may be noted that the amortisation for a certain type of tube depends both on N and T. The following examples of $P = 2100$ and $C = 2.82$ kronor may be given as an illustration.

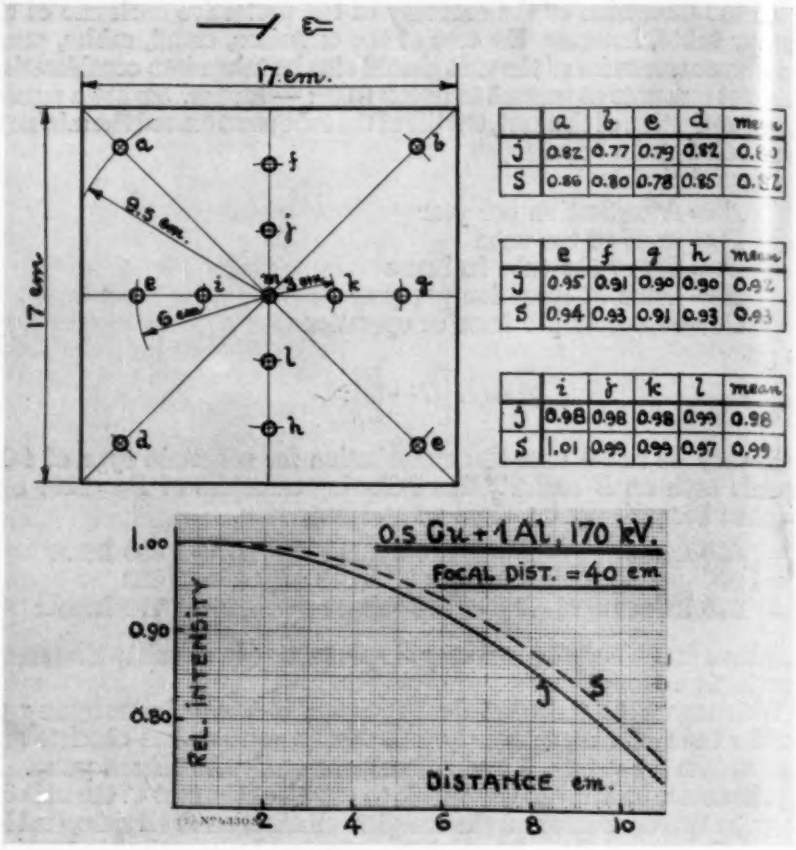
$N =$ 800 hours	$N =$ 600 hours	$N =$ 1 000 hours
$T =$ 1 000 »	$T =$ 1 500 »	$T =$ 2 000 »
$A =$ 576 kronor	$A =$ 853 kronor	$A =$ 1 770 kronor

The above formula makes it a very simple matter to calculate the annual amortisation.

With regard to technical developments, it would be necessary to consider the fact that a therapy unit will be more or less obsolete and inconvenient for practical work after some twelve to fifteen years. It may, however, be thought reasonable to pay $^1/_4$ of the cost of the unit for the protective enclosure and the complete elimination of all risks, and let the remaining $^3/_4$ of the cost, or 6 000: — kronor, be amortised in 15 years by the tubes. This corresponds to a minimum amortisation of 400 kronor per annum. Assuming the very moderate value of $N = 500$ hours and, as above, $C = 3.24$ kronor, the above plan demands a tube life of 860 hours.

If the above plan of amortisation be not accepted, but the whole unit cost is required to be amortised in 15 years by the tubes, we get a minimum amortisation of 533 kronor per annum which, at $N = 500$ hours and $C = 3.24$ kronor, gives a tube life of 970 hours.

The difference between the two calculated values is not very great, and, in the author's opinion, an average of, say 900 hours, may therefore be accepted as the basis of the discussion on the economy of the operating results obtained with thin-walled Doglas tubes in protective



	a	b	c	d	mean
J	0.82	0.77	0.79	0.82	0.[illegible]
S	0.86	0.80	0.78	0.85	0.[illegible]2

	e	f	g	h	mean
J	0.95	0.91	0.90	0.90	0.92
S	0.94	0.93	0.91	0.93	0.93

	i	j	k	l	mean
J	0.98	0.98	0.98	0.99	0.98
S	1.01	0.99	0.99	0.97	0.99

Fig. 1.

enclosure under the operating conditions now in use in Sweden. A reasonable price of a tube which does not last 900 hours is accordingly $\frac{2\,100}{900} = 2.33$ kronor per hour of operation.

This calculation may be applied to all tubes of the similar prices, radiating powers and maximum ratings. For tubes of other characteristics an economical calculation can be made on the same lines.

In connection with this discussion of the employment of the Douglas tube in protective containers, some measuring results of the intensity distribution at the surface of an irradiated body may be of interest. Fig. 1

gives the values of the relative intensity found at various points (designated a—m) in a square field of 17 × 17 cm at the surface of a wax-phantom, using a focal distance of 40 cm, a filter of 0.5 Cu + 1 Al, and a tube-voltage of 170 kV constant potential. The two series of values refer to Järnhem containers (designated J) and Siemens containers (designated S), both types equipped with Doglas tubes. From the diagram it may be seen how far the surface intensity decreases with increasing distance from the centre of the field.

The amount of off-focus radiation in beams of various widths from Doglas tubes in protective containers has been demonstrated by the author in a previous article (*Acta Radiol.* Vol. XVIII, 1937, p. 753), giving a general survey of this problem. Since the results obtained may be of interest in this connection, they are very briefly recorded below. The measurements were carried out by a spherical graphite ionisation chamber (16 mm outside diameter) arranged in the centre of the beam, at a focal distance of 40 cm. Using a tube-voltage of 165 kV constant potential, the intensity of the unfiltered beam was measured free in air, with lead diaphragms with different apertures inserted in the filter-holder. Designating the maximum aperture A and the intensity corresponding to this aperture 1.0, the values obtained with other apertures were as follows:

diaphragm aperture	A	$^3/_4\,A$	$^1/_2\,A$	$^1/_4\,A$	$^1/_8\,A$
relative intensity	1.0	0.97	0.94	0.90	0.87
required increase of irradiation time to get the same dose	0	3 %	6 %	11 %	15 %

These values show that in the beam obtained with maximum aperture about 13 per cent of the radiation is off-focus radiation, a proportion that may be considered relatively favourable. For practical work, however, these results imply that when using very small apertures the irradiation time required to get a certain dose must be some fifteen per cent longer than that required for the same dose at maximum aperture.

SUMMARY

This article contains a study of the practical experience gained from operating results in Sweden during five years of using modern protective containers for roentgen therapy tubes. Special attention is devoted to the economy of the operation, e. g. to the life of the tubes in relation to their price, to the cost of the protective units, and to the amortisation of the unit cost. The result demonstrated may be considered particularly reliable, since the operating conditions of the therapy tubes used in Sweden, for more than eleven years have been very uniform, and are physically and technically checked by direct measurements twice a year. This important fact has also made it possible to discuss the operating results of the tubes used in modern protective containers on the basis of the extensive experience collected from the use of other tubes without protective enclosures.

ZUSAMMENFASSUNG

Dieser Aufsatz enthält eine Zusammenstellung der fünfjährigen praktischen Erfahrungen und Betriebsresultate, die in Schweden bei Verwendung von modernen Schutzhauben zu Röntgentherapieröhren gewonnen worden sind. Besondere Aufmerksamkeit ist hierbei der Betriebsökonomie zugewandt worden, und wird im Zusammenhange hiermit das Verhältnis zwischen der Lebensdauer der Röntgenröhre und deren Preis, den Totalkosten der Schutzhaube nebst Zubehör und der Amortisation der Anlagekosten untersucht. Die hier vorgelegten Resultate können als besonders zuverlässig bezeichnet werden, weil seit über 11 Jahren die Betriebsbedingungen aller schwedischen Therapieröhren sehr gleichmässig sind und durch physikalische und technische Messungen zweimal im Jahre kontrolliert werden. Dank dieser günstigen Umstände ist es überhaupt möglich geworden, die Betriebsverhältnisse von Röntgenröhren in modernen Schutzhauben im Vergleich zu den grossen Erfahrungen mit andern Röntgenröhren und älteren Ausrüstungen ohne Schutzhaube, zu diskutieren.

RÉSUMÉ

Cet article contient une étude sur l'expérience pratique et les résultats de fonctionnement obtenus en Suède pendant cinq ans en employant des cuves de protection modernes pour des tubes de Roentgen thérapeutique. Surtout on a fait attention à l'économie du fonctionnement, par example la vie des tubes à raison du prix des tubes, des frais des cuves de protection et des accessoires et de l'amortissement des frais totals. On devrait pouvoir trouver les résultats produits particulièrement sûrs, comme les conditions de fonctionnement des tubes thérapeutiques employés en Suède pendant plus que onze ans ont été très uniformes et sont contrôlées physiquement et techniquement par des mesures directes deux fois par an. Ce fait important a rendu possible la discussion des résultats de fonctionnement des tubes employés dans les cuves de protection modernes sur la base de l'expérience considérable qu'on a fait sur d'autres tubes et des vieux équipments.

CONCERNING THE DIFFERENCES BETWEEN RADIOLOGICAL AND ANATOMICAL MEASUREMENTS[1]

A study of röntgenographical contures with special reference to the precision of different measuring methods and the prospects of their development,

by

Carl Wegelius

The röntgenological determination of size and position has proved to be of great value for medical diagnosis. — The best known are the heart measurements in which the pathological changes in size and form can be shown by röntgen photography in by far the most certain way. Equally supreme are röntgenological methods in surgery for the localization of foreign bodies and tumours. Further, to mention one more of their many spheres of usefulness in gynecology, röntgenological measurements of the pelvis and the fetus head have proved of great value.

It is peculiar and remarkable that there are such numerous ways in which, in medicine, röntgenological measurements can be taken in any and all of the cases mentioned. There has been no standardization of methods although they are all based upon the same uniform projection geometry. The different nations have their own schools in the matter, and within the same country, the determination of size is indicated in the most varying ways. For example, heart measurements in Germany, France and Italy have been differentiated in widely different manners. We need only think of GROEDEL's transverse diameter, VAQUES' oblique diagonals and PALMIERI's plastic procedure. The same conditions prevail in regard to gynecological pelvis measurements, the methods of which can be reckoned by the hundred, and methods for localizing foreign bodies are also specially numerous.

This multiplicity of different variations in röntgenological proceeding depends, it is true, partly on the fact that different researchers have restricted themselves to different part factors of röntgenological measuring,

[1] Submitted for publication April 16, 1938.

such as form, or extension, or volume. This, however, is clearly due to the difficulties of obtaining in general reliable, precise results by this method. There are at present, for one and the same object, as for example for measuring the pelvis cavity, several dozen ways, and the methods of determining the heart volume are still more numerous. The reason for these uncertainties lies in certain conditions peculiar to röntgenological conture formation, which, more than hitherto, deserve consideration when such methods are applied. An analysis of these presumes the determination of certain primary conceptions from geometry, such as are employed in forming shadows and shapes. On the basis of these the different principle of procedure and the possibilities of their development can be more closely studied.

The weak point in the röntgenological measures of the shadows is chiefly that they are not absolute values but only so-called relative measurements. The contures in a röntgen picture form the plane projection of the corresponding parts of the object studied. As these parts lie at different distances from and in different relations to the plane of the picture, the distance is projected either shortened or lengthened, and the outlines are distorted in accordance with its changed position to the plane of the picture and its relation to the beam. To give objective value to the measurements and to make them mutually commensurable it is desirable to convert the *»relative measurements»* of the shadow into absolute figures. This implies that they must be valid, not for the distance as projected in the picture, but as they actually are between the corresponding points on the projected object. In this way they would be equal in value to the so-called *»anatomical measurements»*, liberated from variable factors, and could be given absolute values.

In röntgenological measuring, the shadow on the film, the focal distance, and the rays are the known factors in a system where the size of the object casting the shadow is sought. The problem is solved by projectional geometrical construction. In regard to the objective exactness it will be presumed here that the shadow is fixed at a given moment and that the result can be worked out projectional geometrically without using optical apparatus for stereoscopic sight (WEGELIUS l. p. 8). For this reason two valuable principles in röntgenological measuring, viz. *orthodiagraphy and stereometry*, are not being treated in this presentation. Further it is assumed that the focus is a point, and no special attention is paid to the boundary and central shadows of the röntgen photograph. A distinction between these two is not necessary in the technique at present in use with its great focal distance and small focal spots.

If a convex body in darkness is illuminated by one point of light, then that part of the body on the side facing the light will be illuminated, and the opposite side which is in darkness is called the *self shadow*. The

boundary between the two parts is in the shape of a ring running unbroken round the surface of the body. This boundary line determines the shape of the shade which, with the point of light as projection centre is thrown out in the direction of the dark side. Wherever a surface is laid in the path of this shade a section picture is caught upon it in the form of a shadow. Its contours are to be regarded as projections of corresponding parts of the boundary line, each point of which has its corresponding point in the shadow. The special points on the edge of the self shadow are for this reason called *contour forming points.*

The relations between the contour forming points, the shade and the shadow are shown in fig. 1. A sphere is illuminated from F and the boundary of its shadow is caught on the XYZ plane in the form of contour curve k'. O is the centre of the sphere and O' indicates the end point of the line FO' perpendicular to the plane. The points F, O and O' are assumed to lie in the same straight line, the centre ray which is at right angles to the plane. The self-shadow's boundary on the sphere runs in the form of a curve k, each point of which is reflected on the contour curve. Thus A' corresponds to A, B' to B. The line AB is reproduced as A'B'; the relation between these two lines depends upon the divergence of the rays and can, in the well-known way (the relation of equal triangles), be determined if the focal distance and AB's distance from the plane are known. The enlargement of the shadow is in indirect proportion to the ratio FO' : FO. Teleröntgenography with a long focal distance works on this principle for the reduction of the shadow enlargement.

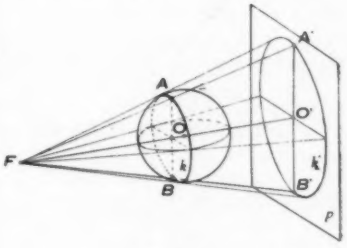


Fig. 1.

In a spherical object all the contour forming points are at the same distance from the focal point on the one side and on the other side the plane. If a plane section is taken through the sphere at the curve k, this curve limits a plane section through the object which is reflected on the shadow as the conture line k'. The distinctive fact in medical röntgenprojection is that the shadows are obtained as the primary result. Proceeding from them it is necessary in the second place to consider the configuration and size of the corresponding section in the object itself. For this reason the term *primary picture* is given to the direct shadow, while the section in the object of which it is the shadow is given the name *secondary picture* or *real section*. The latter has a real extension in the projected object, it forms, so to say an anatomical measure while the former is a shadow varying with the projection conditions. Thus in fig. 1 the section through the curve k' is the real section, while the surface with the contour k' on the shadows is the primary picture.

The contour curve, the limit of the real section, always lies in central projection, as a so-called small circle on the sphere's surface nearer to the light than the plane of the shadow, according more or less, to whether the focal distance is short or long. This means that in an ordinary röntgen picture the real section is always taken through the parts lying on that half of the object farther away from the film. So that in general when the heart is photographed we see the silhouette of those parts of the heart more to the back.

Only when the central ray is at right angles both to the plane and the real section, as in fig. 1, is the primary picture similar in shape to the real section. On the other hand if the plane is oblique to the central ray, as shown in fig. 2, then the projection alters its shape in relation to the real section. A shadow of the sphere projected at an oblique

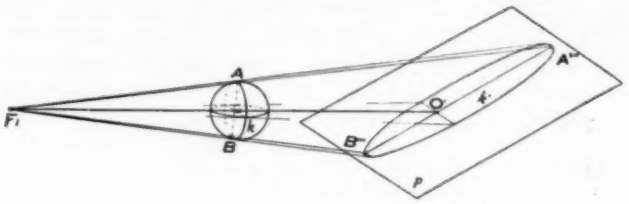


Fig. 2.

angle of incidence is formed of a conic section, the kind and shape of which depend on the obliquity of the angle of incidence, i. e. angle FO'B'''.

Fig. 1 shows how with the central projection of a sphere all the contour points lie along a circle so that the real section as a whole lies in one and the same plane. Besides the sphere there are also other convex bodies bounded by curved surfaces of second degree of which the real section limits lie in one single plane, viz. ellipsoids and paraboloids. Most of the internal organs with which medical measurings are concerned are bounded by such curves, as shown by WEGELIUS Nr. 1. p. 122. If there are concavities in the surface of such an object predominantly convex, the points on the boundary will not all lie in the same plane as the real section, the curving of the boundary at these parts will be of a component nature and its lineal length will, in general, be increased in comparison with what it would have been if the convex boundary had been complete.

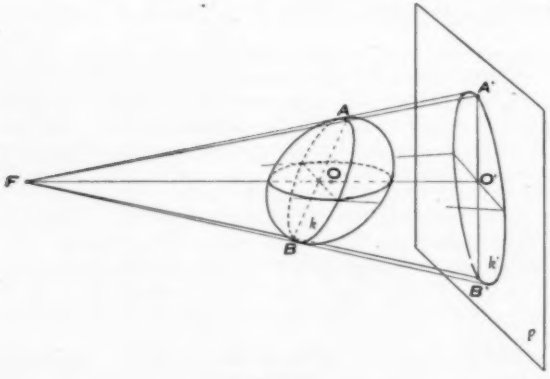


Fig. 3.

In a sphere all contour points lie at the same distance from the focus, the real section is perpendicular to the central beam and is reflected as a primary picture of the same shape. But bodies of irregular shape, for example an ellipsoid, can have different positions in relation to the focus and the plane. The contour of the real section is thus outlined differently along the surface of the object and the change in its configuration is due to its position to the plane. Only if the real section is parallel with one of the ellipsoid's chief planes is the central beam at right angles to these two and the primary picture is unchanged in shape. But as soon as the real section stands oblique to the plane, as is shown in fig. 3, a new factor comes to

play in the formation of the shadow. The contour forming points along the real section lie at different distances from the plane. The line between two such points, e. g. A and B, is oblique to the plane and the shadow is therefore correspondingly foreshortened, similarly the line A′B′. Point A is shown as nearer to and point B as farther from the plane. Only those chords in the contour ellipse which are parallel with the plane throw a shadow without this foreshortening which affects all other distances between the different contour forming points. The configuration of the contour curve is altered to the same degree, the real section's shadow has no longer the same form as the real section itself. This effect, which in the theory of röntgenological representation is called *shadow distortion*, is wholly independent of the shadow enlargement determined by the beam's divergence. It exercises the effect in the same way at each degree of divergence of the rays, and also in the case of parallel projection. The *orthodiagram's* shadows are thus as much distorted as the usual centrally projected picture.

The effect of this projective foreshortening of the reproduced lines — »distortion» — due to the oblique position of the real section, so much resembles the »oblique projection» that the real sections are shewn as shadows of a different shape, that is, not representing their real shape. With oblique projection in medical röntgenology it is technically possible to read off the obliquity of the plane outside the human body in relation to the beam's path and to consider it when taking measurements. On the other hand the röntgen projected object hidden amid surrounding tissues eludes a direct determination of shape and position. *The effect of the »distortion» is therefore not distinguishable in ordinary röntgen photography, from which it follows that the determination of shape, position and size is correspondingly uncertain and misleading. These conditions should to some extent explain the difficulties of obtaining »anatomical measurements» with röntgenography and the consequent difficulty of attaining reliable and commensurable quantity values.*

What practical importance has this projective variation? How great is the difference between »radiological» and »anatomical» measurements in medical röntgen photography? In photographing the heart, as shewn by WEGELIUS (N:o 1, p. 116) the real section of the heart reflected on the plane can be up to an angle of 33° to the plane of the film. By the distortion the transverse diameter of a normal sized heart can under such conditions be shown as much as 3 cm. shorter than what it really is, measured between corresponding contour forming points in the heart itself.

Anatomically correct casts in natural size of the internal organs, for example the heart, have, like photographic films, been covered with composition sensitive to light. When their shadows from a point of light were projected on to a plane and there photographically fixed, there was a reproduction of the conditions in medical röntgen photography. The cast's focus side was illuminated and the light-sensitive covering was blackened by the light, while the shadow side remained pale. The boundary between these two is the contour forming curve, the real section's limits. In this way the real section's position to the plane could be determined by direct measurements in different projectional directions at the same time as the silhouette's distortion.

The obliquity depends on the heart's position, which varies with the breathing movements, and its shape, which varies with the phases of contraction. If photographed some moments later, the same heart can be so much less oblique to the plane that there is no distortion at all. This means that the transverse diameter may then be projected without foreshortening, that is a full 3 cm. longer than at the preceding moment. Within the limits of such an extreme case, the variations are of greater or less degree. The differences do not only affect the diameters, i. e. the linear distances between two corresponding points on the contours curve; the whole shape of the heart's silhouette is reproduced more or less unlike the shape of the real section according to the degree of obliquity. All this is completely independent of the shadow enlargement determined by the beam divergence, which causes a lengthening of the primary picture in contrast to the shortening of the shadow's distortion. It is obvious that the accuracy of the measuring of the heart must suffer considerably from the possibility of a projective variation of several centimetres. It is the same in gynecological measurements. A relatively small obliquity of the pelvis of 25° to the plane involves a distortion reduction of conjugata vera of 1 cm., (v. SCHUBERT) an error large enough in itself to be important for determining therapeutic indications. In photographing the fetus head the distortion can cause a difference between the »radiological» and »anatomical» measurements of the different diameters (quite independent of the shadow's enlargement by beam divergence) — of as much as 2 cm. (WEGELIUS Nr. 2). This implies that these measurements are projected and read off 2 cm shorter than they actually are: the fetus head is larger than it appears on the picture, which in border-line cases can be fatal for the parturition. These examples show that the effect of distortion can considerably limit the reliability of röntgenological measurements. A correction of these errors by the methods hitherto used has not been of satisfactory certainty.

The enlargement of the shadow due to beam divergence on the other hand can be largely calculated and corrected; work on this subject has aroused keen interest. KÖHLER, ASSMANN and others have worked out so-called multipliers by means of which the transverse diameters in heart measurements can be corrected to the values they would have in parallel projection, orthodiagraphy, that is made independent of beam divergence. These multipliers are worked out for different focal distances. They start, however, with a certain standard value for the heart's distance from the film plane and this must be regarded as implying a considerable approximation, as the variations in the heart's position and the shape of the chest are so great that the deviation from this standard distance can be considerable. The multipliers do not take into consideration the distorting effects of the shadow. Another way of calculating the enlarge-

ment of the shadow is to photograph the object with conditions of known size, a gauge, a metal net, or metal squares, etc. What is specially well-known and much used for obstetric measurements is in France FABRE's graded metal frame, and in America THOM's lead plate perforated at intervals of one centimetre. These and similar comparative measures are projected on to the pelvis picture at a distance and in a position which are judged to correspond with the plane of the pelvis entrance in its relation to the picture plane by manual examination. As the reproduced measurements undergo the same enlargement and distortion of the shadow as the pelvis bones, this process gives theoretically the possibility of calculating and correcting the projection variations. But in practice this process has proved decidedly uncertain because of the difficulty of correctly determining by manual examination the real position of the pelvis entrance in relation to the picture plane. GAUSS and SCHUBERT have proved that the varying course of the external conjugate in relation to the true conjugate can produce an obliquity of 25° between them. As the adjusting is calculated from the external conjugate, the measurements can consequently be incorrect up to 1.5 cm. A great number of methods are based upon simple pelvis photographs without an oblique projecting of the standard object. The shadow enlargement is reduced with the multipliers and such calculations as in heart measurements based upon certain standard distance of the object from the picture; they imply in themselves a considerable approximation. But these processes do not consider the distorting effect, they proceed from the assumption that the diameters sought by the manual adjustment of the pelvis to the picture plane are made parallel with it. The technical difficulties of this and the possibility of asymmetry involve a factor of considerable uncertainty. Even a relatively slight obliquity is attended, as shown above, by an error of several centimeters, which is enough to be of decided importance clinically.

The same is true of all one dimension röntgenological measuring methods in general; they do not determine the distortion effect. The methods given by LEVY DORN for finding and photographing the largest or the smallest shadow are also uncertain in this respect. The attempt to determine under rotation in a transparent control a dimension at right angles to any chief plane of the object and in this way to avoid distortion can scarcely be made in practice, as the chief planes usually run obliquely to the object's length and thus cannot in general be reproduced parallel to the plane.

Nor does teleröntgenphotography — photographing at a long distance — solve the question of correcting the errors of distortion. In fig. 4 is shown how the lengthening of the focal distance from F to F_1 entails no possibility of localizing the contour points in respect of the picture plane or of a calculation of the distortion based upon it.

On the contrary, we reproduce different parts of the object's surface, in the former case A and B and in the latter A_1 and B_1. The possible obliquity of the lines AB or A_1B_1 cannot be determined in this way, and the effect of distortion remains wrapped in doubt.

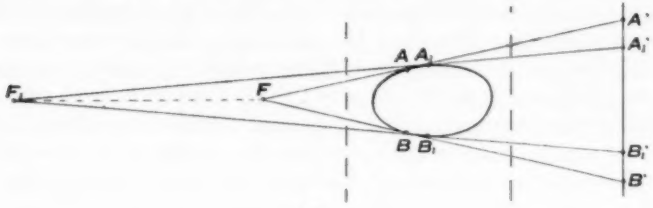


Fig. 4.

The only possible way of obtaining measurements independent both of shadow enlargement and shadow distortion would be to read off the measurements from the real sections themselves, not from the primary pictures. They would then really correspond to the so-called anatomical measurements. It is peculiar to medical röntgen processes that we can never directly see or measure the object whose shape and size we wish to determine. We have only the projected shadows, the primary pictures, to go by, and it would thus mean starting from these primary pictures to construct the corresponding real sections in the object. For this purpose WEGELIUS has given *a method of re-projecting the primary picture to the corresponding real section or secondary picture.* (No. 1). The principle of this is shown in fig. 5.

In the picture plane P a hole is cut out corresponding to the shadow's contour k'. This hole is lit from the back by light converging towards the point F, which corresponds to the röntgen focus distance and position at the moment of photographing. Now, if a plane R corresponding to the plane of the real section is laid between the focus and the primary picture, the converging beam will throw upon it a negative shadow with the contour k which corresponds to the contour k_1, in the primary picture. The converging lines indicate the path of the rays as shown in the figure. This process is the direct opposite to that producing the röntgen picture and the term proposed for it is *re-projection.* There the contour k from the real section plane is reproduced with rays diverging outward toward the picture plane. Now the picture is re-projected with convergent rays to its original position on the real section plane where it can be photographically fixed like an ordinary photographic film. It makes no difference in the configuration of the shadow that it is reproduced in the first case with röntgen rays and in the second with ordinary light, in both cases the laws followed are the same for the rectilineal reproduction of the shadow. The result of the re-projection is that from the primary shadow a secondary picture is obtained, identical with the size and shape of the real section. *The convergence of the rays in the re-photographing removes the shadow enlargement of the primary picture due to the rays' divergence.* The picture is reduced just as much as the primary picture was enlarged. Because the plane of the secondary picture is in the same oblique position to the picture plane as the plane of the real section was during the photographing, the distortion effect is removed, the contour takes again its real shape, as it was round the

surface of the object. Fig. 5 shows how the re-photographing eliminates both the shadow enlargement and the distorting effect. In this way a real-section picture is made from the shadow, with anatomically correct measurements and shape.

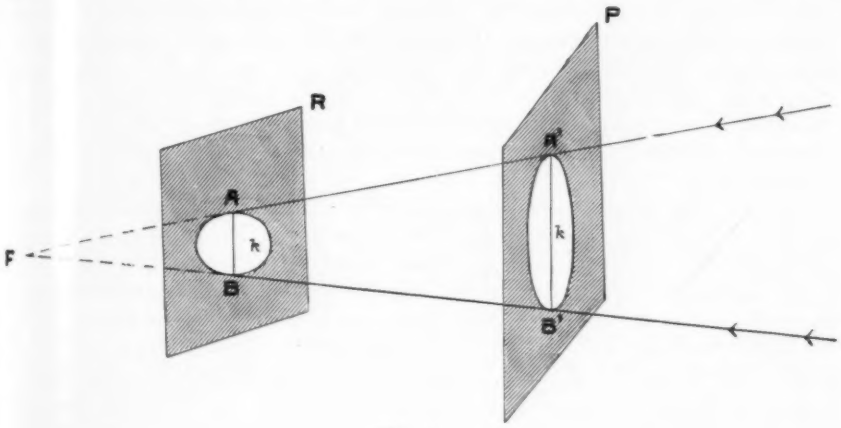


Fig. 5.

The necessary condition for the re-projection is of course that the position of the real section's plane in relation to the picture plane can be determined. The other necessary factors in the projection system — the shadow and the focal distance — are given. To determine the position of a plane, it is enough to know the position of three points in it. In the shadow it is only the points on the contours, which can be distinguished as regards the object. To each of its points there is a corresponding point in the real section's contour, while on the shadow surface otherwise several of the object's points are projected into each other. Our attempts at localization must therefore be confined to these edge points. Their position on the real section's contour must be determined, i. e. how and where they lie between the focus and the picture plane. If we succeed in thus localizing at least three points, or more, the whole position of the real section's plane in the optical system is also determined. We can then carry out the re-projection as above described.

As stated above it is not possible in projections of one dimension to localize some edge points starting from the primary picture. When projecting in several dimensions the conditions are essentially otherwise, for then as many primary pictures are obtained as there are projections. These are the formations each of its self shadow's boundary lines; the object is regarded, so to say, as divided into several real sections cutting each other. The several dimensional projections in medical radiology are

generally limited to two. The most usual angle between the central rays is in this case 90° and the process goes under the name of »right angle method». Only in special cases besides this are oblique angles of incidence used between the directions in question, and in these cases all the dimensions are usually so arranged that they run in one and the same plane at right angles to the length of the surrounding body. Angles of incidence oblique to the length of the body are as a rule avoided as the technical conditions necessary to obtain satisfactory sharpness in the picture are relatively much fewer in proportion as the mass penetrated by the rays is increased.

Among the two dimensional processes the peculiarly numerous methods for localizing foreign bodies are important. These methods are all distinguished by the fact that geometrically they consider the body to be examined as a point, its extent in space is considered of no consequence. It is generally enough that an arbitrary point in the object is localized, whether it is one of the contour-forming points or is projected in the middle of the shadow. This is partly because the foreign bodies to be considered are as a rule relatively small: partly, again, because both the decision as to their importance for the organism and the possibility of removing them from the surrounding tissues are not dependent upon a knowledge of their shape but much more of their position. In removing the foreign body the operator is guided by the information concerning the localized point and aims, so to say, at it. That he, in so doing, comes against the surface of the object as a whole is enough for him to take the necessary therapeutic measures.

Most of the methods for detecting foreign bodies based on two dimensional projection proceed from the parallactic shifting which the object's shadow undergoes in comparison with its original position by a certain alteration in the projecting system. The centre of projection is moved a measured amount parallel with the picture plane, the object and the picture plane retain their places. The photographic fixation of the shadow is done so that the same film in the picture plane is exposed twice and thus shows two separate shadows of the object in question. Fig. 6 shows how point A is reproduced as A′ projected from F and as A_1 projected from F_1, whither the projection centre has been moved. As the lines FF_1 and $A'A'_1$, also FA' and F_1A_1' can be determined, the position of A is thus localized in relation to these points.

Only in a few special cases is it possible with such a parallax to localize the edge points in the object represented. That is when analogous distinct points can be differentiated in shadow contours of both the reproductions so that they can each with certainty be regarded as projections of one and the same contour forming point in the object. In fig. 7 such a case is shown, where the projections A′ and A'_1 are unmistakeably reproductions of the same point A at the point of the object K. In general, however, it is not possible to combine corresponding points in the contours of the shadow's surfaces, because the medical organs in question are more or less rounded, as stated above. If the parallactic combination under these circumstances is attempted between such points in the primary picture's contour as are not analogous but represent different points on the surface of the object, the localization based upon it will give a correspondingly faulty

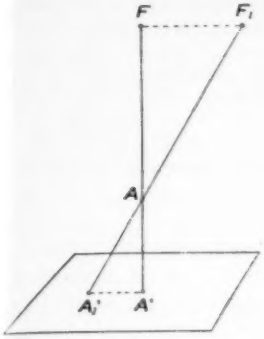


Fig. 6.

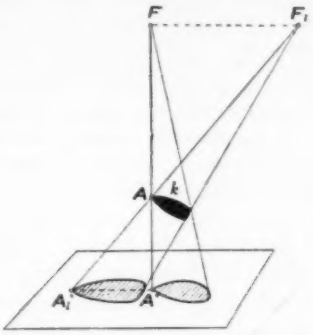


Fig. 7.

result. In fig. 8 is shown how a combination of the different points A′ and A'_1 each in its own shadow-contour places the constructed localization of point A outside the object K itself, which is, of course, absolutely wrong. For the same reasons the localization of the contour points will be unsatisfactory whenever foreign bodies are determined according to the right angle method of working. In such cases naturally very different edge points are reproduced as contour-forming points.

According to the principle employed in Fürstenau's localizator, in HIRTZ' compass and other similar processes the localization takes place on the basis of the change undergone by the shadow of the object under examination in relation to the shadows of certain objects of definite sizes and positions, which are projected at the same time. These projections take place from two definite centres on to the same picture plane. The effect of the shadow's enlargement is read off from tables in which the different shifting of the shadows on the picture plane have been calculated. The different angles of incidence determined by parallax cause different real sections to be reproduced on the shadows. Thus in this process also it is not possible to directly localize the edge points.

In the so-called Needle localization it is assumed that the object reproduced is formed of a straight line the end points of which correspond to the edge-forming points. Under

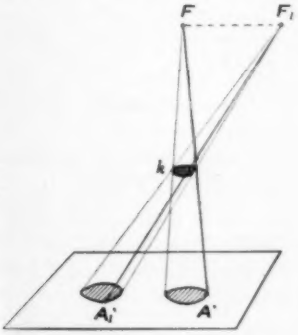


Fig. 8.

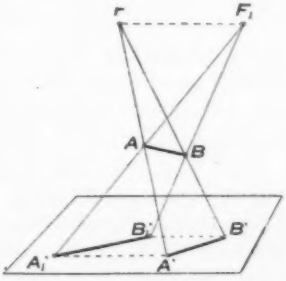


Fig. 9.

this assumption the position of the shadow-producing object can be exactly det mined by means of two dimensional projection in so far as analogous end points in the adows can be combined. These are then localized according to the process described in onnection with parallax. Fig. 9 shows how the line AB at the projection from F and F_1 roduce the shadows A′B′ and $A'_1B'_1$. In localization the analogous pairs A′ and A'_1 and B′ and B'_1 are combined and in this way the position of AB in space is determined.

The localization can be carried out by purely geometrical construction. At the same time practical processes are used which imply a concrete reconstruction of the course of the projected rays.

Among these the thread method of MACKENZIE is to be noticed. In this process the pictures are placed in position in the picture plane. From the projection centres threads are drawn to the end points of the needle's shadows in the picture plane. Where these threads cross in space is the point sought which has been reproduced in the projections. Another modification is given by STUMPF. He uses an optical light which diverges from the sources of light in the projection centres towards the picture plane in the same way as the röntgen rays in producing the primary picture. A needle placed in the path of these optic rays will cast visible shadows on the picture plane. If the needle is moved until each of its shadows coincides with its respective lines in the primary pictures, it will then indicate the position of this corresponding line in the object as it was when the primary photograph was taken. Its real length is also at the same time determined if the length of the projected needle is marked so that it corresponds with the lines projected on the pictures. — The so-called plastic process is a special type of röntgen determination of size. The distinctive character of it is that a plastic mass is cut by means of a number of sections based on the shadows in such a way as to obtain a body representing the object reproduced. The primary pictures are obtained by projection at different angles of incidence as the object is rotated in an aggregate of connected focus and picture plane. In doing this PALMIERI, LYSHOLM and KLASON use central projection, while SCHATZKI uses orthodiagraphy. The limiting of the plastic body is done by means of a reconstruction of the rays' path. Starting from the shadow its contour is cut out in the mass with a line corresponding to the path of the rays where they touch the object.

The methods of working are different in some special modifications in that PALMIERI carries out the cut on the object's place in a special phase after the primary picture has been obtained, while the other researchers do it at the same time as the picture is produced. The final result of the plastic shaping is a more or less angular body with each edge corresponding to the cut of one of the shadows.

As the spaces between the different reproductions lessen the section lines on the cut surface run nearer to each other and the object comes more

rounded. But in medical practice the number of possible projections is so limited that there is no little angularity in each. From this it follows that a special point in the shadow's contour can be localized in the direction of the projection rays all along the surface corresponding to the edge. This implies that the object's configuration can vary within the limits of such a definite section. For this reason a localization of an edge point by such plastic methods will be correspondingly misleading.

Thus all many-dimensional processes are distinguished by the fact that in directly reading off the shadows they do not permit of an exact localization of the edge-forming points in an object with rounded contours. As, therefore, all medical organs whose size is to be determined are decidedly rounded bodies, another indirect way must be used for localization. This is based upon the relations of the real section to the projection system. If the shadows of a convex object are produced at angles of incidence oblique to each other, then, as is clear from the above explanation, the real sections also have to be oblique to each other. Two boundary lines of the real sections on the object's surface will cut each other somewhere at two opposite points. As each real section as a whole is reproduced in the corresponding primary picture it follows that the real sections' points of intersection are reproduced in both shadows at the same time. The name introduced for these points on the object's surface is »fixed points» because their position can be fixed because they appear in two places. The construction process for this based on the projection conditions is shown in the explanation attached to fig. 10.

Fig. 10 shows the relations when the convex object K is simultaneously projected on to the picture planes XZ and YZ at right angles to each other. Here P_1 and P_2 are the centres of projection. The central ray from P_1 on to the plane YZ meets it in Q_2. The central rays cut each other at right angles at the point Q. The object K is assumed to be so placed that Q falls within its limits. The tangents to K's surface drawn through P_1 form a cone of rays, of which the curve cutting the plane YZ forms the contour of the shadow cast by the object on this plane as the illumination comes from P_1. The contour curve in the picture plane is marked k'_1. In a similar way tangents are drawn to K from point P_2. They cut the plane XZ along the contour k'_2 which in this plane is the boundary line of K's shadow when the light comes from P_2.

The tangents to K from P_1 touch the object's surface along a curve marked k'_2, and the cone of rays from P_2 along another curve k_2. The curves mentioned above, k'_1 and k'_2, can be considered as projections in the picture planes of the curves k_1 and k_2 respectively. As the cones of rays from P_1 and P_2 converge towards K and are assumed to cut each other at an angle of less than 90°, the curves k_1 and k_2 must also cut each other. This happens, if K is assumed to be wholly convex, in two points which are marked A & B. The lines P_1 A and P_2 A are both tangents to K's surface, so the plane laid through these lines form the tangential plane to this surface with A as the tangential point. At the same time this plane is a common tangential plane to the two cones of rays with P_1 and P_2 as their points.

This plane through P_1P_2 and A contains also the line P_1P_2 and therefore also (P_1) and (P_2) which indicate the points where this line cuts the planes XZ and YZ respectively.

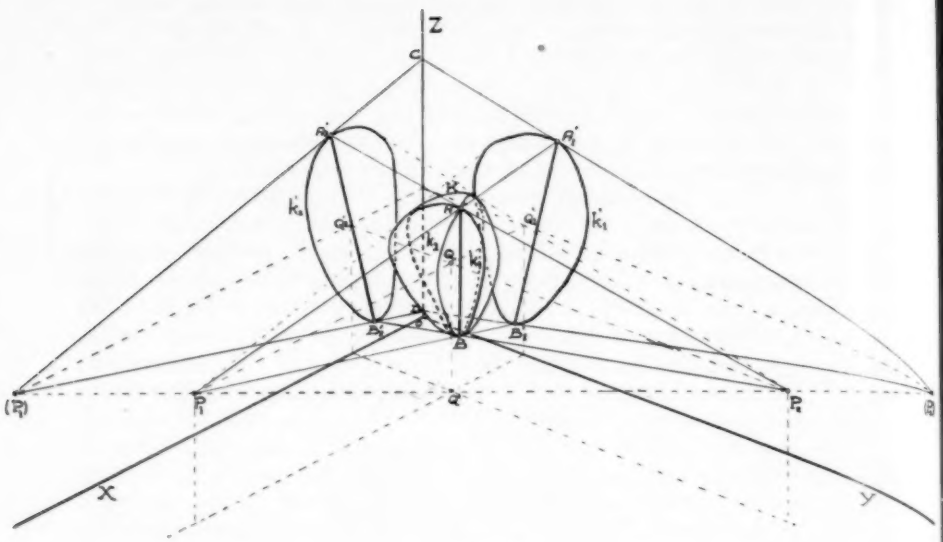


Fig. 10.

The tangential plane in question cuts the planes XZ and YZ along two lines (P_1) C (P_2)C which meet in point C on the cutting line OZ of those planes. As the plane through A, P_1 and P_2 is a common tangential plane to these cones of rays, it follows that the lines (P_1) C and (P_2) C form tangents to the curves k'_1 & k'_2 respectively so that the tangential point of the former A'_2 is the projection of point A from point P_2 and the tangential point of the latter A'_1 is the projection of point A from P_1. As the points A'_1 and A'_2 are known, point A can be determined by means of them, because it is the cutting point of the lines P_1A_1' and $P_2A'_2$. — In the same way the opposite point B on the surface of the object can be determined through its projections B'_1 and B'_2 which are the tangential points for those tangents which are drawn on opposite sides of the shadow to the curves k_1 and k_2 in their picture planes from the projection points (P_2) and (P_1) respectively.

In summarizing, these conditions can be expressed so that the constructive processes described make it possible to find the projections on the primary picture of two fixed points in two dimensional reproduction. As the projections of these points are found they can be localized in the relation in which they stand on the surface of the object to the projection system. In this way the actual line between them can be determined both in length and position. This can be done in a purely constructional way, starting from the relations between the measured lines in the primary picture and the projection system. This line can, however, as a line also be determined absolutely exactly in a practical way. To do this it is

helpful to use the optical Needle localization process, which is described in detail in connection with fig. 9. In the projection system two picture-planes are used corresponding to those in which the primary pictures are represented. From the corresponding centres of projection diverging optic light is sent which produces, each in its own picture plane, the shadow lines of a movable needle placed in the position of the object. When the point is given such a position that its shadows coincide each with its projection line in the picture planes, it then has, in relation to these, a position corresponding to the actual lines in the object which it had at the moment of the primary projection.

In the case described in connexion with fig. 10 it was assumed that the central rays cross each other at right angles, as is the case in the right angle method so often used in medicine. There are also, of course, the same possibilities of localizing fixed points with the cones of rays at greater or less angles to each other and quite independent of the difference between the focal distances.

Thus, with two dimensional projection of a convex object it is possible to localize two opposite boundary points. These are the two »fixed points» which are reproduced twice over, i. e. each in its contour curve on the shadow, because they occur at the common cutting point of the corresponding real sections. An assumption here is that the projections are made at such angles to each other that the boundary curves of the real sections — the sections through the object — cut each other on its surface. The position of the other contourforming points cannot be determined, they have only been projected once.

When forming a shadow in three dimensions the question of localizing the contour points is completely solved. The whole of the contour curve through the edge points is localized, i. e. the anatomical size and shape of the real section can be exactly determined. This is done by combining in pairs the shadows obtained. The result is that *in all six fixed points are localized* on the surface of the object. The real sections taken through the object cut each other in two, the cutting lines being formed of the lines between two opposite fixed points. As each real section has such a cutting line in common with each of the other two real sections this means that in itself it has two such cutting lines or »common chords». As the end points of these common chords are localized fixed points there are in the contour curve of each real section four determined contour points. Above, in connection with fig. 5, it was emphasized that the localization of at least three points in the real section was sufficient for carrying out re-projection. These conditions are fulfilled in localizing four fixed points and thus the real section can be obtained optically with converging light and photographed as shown in fig. 5.

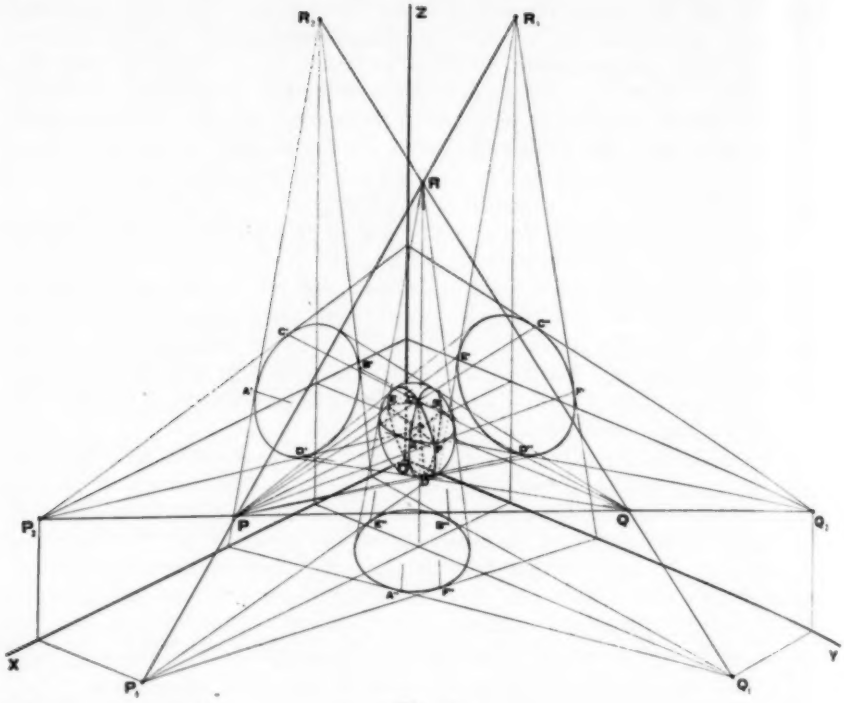


Fig. 11.

Fig. 11 shows the mutual relations of the three dimensional projections. From the three centres P, Q & R is projected on to the picture planes XZ, XY & YZ a convex object lying at the common cutting point of the three central rays. These planes cut each other in the lines OX, OZ and OY, so that the central rays correspond to the axles in a right-angled co-ordinate system. Other angles can also be used. The six fixed points, A & B, C & D, and E & F form the end points in pairs of their common chords. The projections of these chords on the shadow are marked with corresponding letters. The starting points for the tangential construction — the projections of the centres producing the pictures in the respective planes — are shown by numbering the corresponding P, Q, and R. The lines meeting in pairs in the cutting lines in the picture plane and running through the analogous fixed points start from the points P_1 and R_1, P_2 and Q_2, and R_2 and Q_1. In the reproduced object the contour curves of the real sections are shown and their common chords.

By means of the three dimensional process and re-projection it is possible not only to obtain the antomical size and shape of the real sections, but these sections by being combined at their common chords can be placed together in the real position they occupy to each other at pro-

jectio . This is of great practical importance. It has been explained above how, r example, the real sections of the heart can be oblique in relation to the picture plane up to an angle of 33°. Naturally they can with three dimen ional right angle projection in relation to each other have a still greate obliquity according to the configuration of the surface of the objec It is remarkable that pictures taken at an angle of 90° to each other an correspond to the real sections in the object which are at angles of 40° and 160° to each other as shown in fig. 12; the contour of the o ject corresponds to a standard transverse section of the heart projected in the ordinary way on to the frontal and sagittal planes; it is taken from ROUVIÈRE: *Anatomie humaine* 1924.

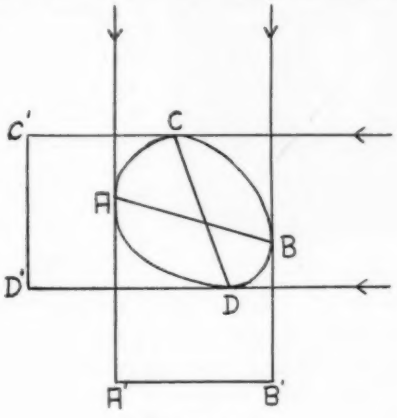


Fig. 12.

AB and CD are the chords, each in its real section plane, corresponding to the projected picture A'B' and C'D' at right angles to each other. It is worthy of remark that there it is assumed that the heart pictures taken at right angles to each other can in this way correspond to those parts of the edge on the surface of the object which are in such extreme obliquity to each other. In the same way, not only in connexion with the heart but with any other organ, there is a more or less considerable possibility to be misled due to shadow distortion of the obliquity of the real sections to the picture plane. The parts of the object we have reproduced are in quite other relations to each other than the angles between the projections we have used. *However, the three dimensional process explains the real sections' positions to each other and make it possible to combine them anatomically correctly into »three dimensional pictures».* Two or three such complete three dimensional pictures obtained from an object in a definite optic system could be further combined into »polydimensional pictures», by means of which a more complete delimination of the object's actual size, shape, and also volume, is obtained. They must in this case be referred to the same coordinate system as shown by WEGELIUS (1. page 44). Fig. 13 shows such a polydimensional heart picture obtained from two three dimensional heart pictures. The real sections have been cut out in cardboard and joined along their common chords.

The three dimensional process can thus be adapted to all kinds of röntgenological localization and measuring, and thus in several ways lends

itself to the improvement of the exactness of results and the increase of differentiating possibilities.

In localizing foreign bodies, tumours, and similar objects not merely their size and shape can in this way be determined more precisely than with other methods, but also their topographical relations to neighbouring röntgenologically visible organs. All distances to the picture plane and the projection centres can be exactly determined.

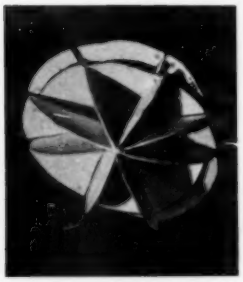


Fig. 13.

In diagnoses of the pelvis the actual shape and size of the entrance can be exactly determined with complete elimination of any errors due to shadow distortion or enlargement. With three dimensional localization of three or more definite points in the plane of the pelvis, its position to the picture system can be determined. By reprojecting the shadow on to this plane, an anatomically correct real section of this part of the pelvis is obtained. In the same way other, deeper sections of the pelvis canal can be measured. The size, shape, and position of the head of the fetus can also be determined without the misleading due to projection.

In heart diagnoses the three dimensional process gives similar possibilities to obtain anatomically correct measurements and shape of that organ. Further the courses of parts of the contour along the surface of the heart are localized; it is possible to determine whether the shadow contours we see reflect the front or back of the heart and how they stand to each other. Reliable determination of shape is also possible as the effects of distortion are eliminated. Finally three dimensional pictures — by their exactness — facilitate the röntgenological determination of volume — especially for the purpose of comparison. Such measurements of variation in the volume of the bladder have been made by WEGELIUS(3).

SUMMARY

Medical röntgen pictures, as shadow projections, are misleading both in size and shape, there are more or less considerable differences between »radiological» and »anatomical measurements». The errors due to divergence of rays, enlargement of shadow which, while retaining the shape, lengthen the picture, can be calculated and corrected with a considerable amount of precision. On the other hand we cannot determine the effect of shadow distortion due to the obliquity of the object to the picture plane. This produces, in contrast to shadow enlargement, a foreshortened reproduction of corresponding distances in the object, the anatomical measurements are decreased. This happens in various degrees in different parts according to the shape and obliquity of the object, and in this way the reproduction will differ in shape from the section through the object of which it forms projection. The shadow gives a »distorted» picture of the anatomical shape of the

edge-forming parts of the object photographed; it does not correspond to a section through it but only to a projection.

The different possibilities of being misled in localization and measuring through this projectional variation are described. A process of three dimensional projection is described by which the misleading shadows, by means of convergent optical projection from the picture plane to their former position on the object's place in the projection system are made to take on again the anatomical shape and size of the contour parts. They are altered from shadows to »real sections». These, by considering their mutual obliquity, can be anatomically correctly combined into »three dimensional pictures» which then give the delimination of the object examined in three dimensions. Examples are given of the application of the three dimensional process in determining by röntgenology the position, size and shape of internal organs.

ZUSAMMENFASSUNG

Die medizinischen Röntgenbilder sind infolge ihrer Natur als Schattenprojektionen, sowohl in Bezug auf die Grösse als auch auf die Form irreführend; es bestehen mehr oder weniger beträchtliche Differenzen zwischen »radiologischen» und »anatomischen Massen». Irrtümer infolge von Strahlendivergenz, Schattenvergrösserung und die dadurch bei Beibehaltung der Form entstehende Verlängerung des Bildes können mit einem beträchtlichen Mass von Genauigkeit berechnet und korrigiert werden. Anderseits können wir die Wirkung der durch die schräge Richtung des Objektes zur Bildebene hervorgerufene Schattenverzerrung nicht bestimmen. Diese bewirkt, im Gegensatz zur Schattenvergrösserung, eine verkürzte Reproduktion der entsprechenden im Objekt vorhandenen Distanzen; die anatomischen Masse sind verringert. Dies geschieht auf verschiedenen Gebieten in verschiedenem Grade, je nach der Form und Schrägbildung des Objekts, und dadurch wird die Form der Reproduktion sich von der des Schnittes durch das Objekt unterscheiden, von dem das Röntgenbild nur die Projektion gibt. Der Schatten gibt ein »verzerrtes» Bild von der anatomischen Form der kantenbildenden Teile des photographierten Objekts; es entspricht nicht einem Schnitt durch dieses, sondern nur einer Projektion.

Verf. beschreibt die verschiedenen Möglichkeiten der Irreführung, der man in Bezug auf Lokalisation und Mass durch diese Projektionsveränderung ausgesetzt ist, und schildert einen Prozess von dreidimensionaler Projektion, durch den die irreführenden Schatten mittels konvergenter optischer Projektion von der Bildebene zurück zu ihrer früheren Lage am Platze des Objektes im Projektionssystem dazu gebracht werden, die anatomische Form und Grösse der Konturpartien wiederanzunehmen. Sie sind von Schatten zu »wirklichen Schnitten» geworden. Diese können unter Berücksichtigung ihrer gegenseitigen schiefen Lage zueinander anatomisch richtig zu »dreidimensionalen» Bildern kombiniert werden, die dann die Delimination des in drei Dimensionen untersuchten Objektes geben. Verf. gibt Beispiele von der Anwendung des dreidimensionalen Prozesses bei röntgenologischer Bestimmung der Lage, Grösse und Form interner Organe.

RÉSUMÉ

Les clichés roentgen médiaux, tels que des projections d'ombres, sont trompeurs tant au point de vue dimensions que formes, et il existe des différences plus ou moins considérables entre les mensurations »radiologiques» et celles »anatomiques». Les erreurs dues à la divergence des rayons et à l'élargissement de l'ombre qui tout en retenant la forme allonge l'image, peuvent être calculées avec un degré de précision considérable. D'autre part, nous ne pouvons déterminer l'effet de la distorsion de l'ombre due à l'obliquité de l'objet par rapport au plan du cliché. Ceci occasionne, contrairement à l'élargis-

sement de l'ombre, une reproduction réduite, en perspective, des distances correspondantes dans l'objet, les mesures anatomiques étant réduites. Ceci se produit à des degrés divers dans les différentes parties, suivant la forme et l'obliquité de l'objet, et la reproduction différera ainsi au point de vue forme de la section à travers l'objet dont elleforme la projection. L'ombre fournit une image »distordue» de la forme anatomique des parties formant saillant de l'objet photographié; elle ne correspond pas à une section à travers l'objet, mais seulement à une projection.

L'auteur décrit les différentes possibilités d'être induit en erreur, par cette variation projectionelle, au point de vue localisation et mensurations. Il décrit ensuite un procédé de projections à trois dimensions, grâce auquel les ombres trompeuses sont amenées à reprendre la forme et les dimensions anatomiques de leurs contours, au moyen de projections optiques convergentes du plan de l'image à leur ancienne position à l'emplacement des objets dans le système projectionnel. Elles sont ainsi transformées, passant d'ombres en »sections réelles». Ces dernières peuvent être combinées de manière anatomiques correcte en »images à trois dimensions», en tenant compte de leur obliquité mutuelle, ces images donnant la délimination de l'objet examiné sous trois dimensions. L'auteur fournit finalement des exemples de l'application du procédé à trois dimensions pour la détermination roentgenologique de la position, des dimensions et de la forme d'organes internes.

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THE RÖNTGEN DIAGNOSIS OF TUBERCULOUS SPONDYLITIS[1]

by

Nils Westermark and *Gösta Forssman*

Tuberculous osteitis forms either focal or diffuse infiltration. It is a purely destructive process, which destroys the framework of the bone. According to the tendency to osteous necrosis we distinguish two types of tuberculous osteitis, namely, the granulating fungous form, which resorbs the bony framework and the caseous form, which brings about necrosis of the lamellae.

From a pathological standpoint the characteristic feature of the granulating type is the appearance of genuine tubercles with giant cells and central caseation, fibrous connective tissue formation and lacunar resorption of the bone lamellae. In this way there arise rounded or irregular shaped cavities within the bone or else more or less deep erosions at its surface. The latter are filled with necrosing tuberculous tissue and remnants of destroyed lamellae. Sometimes this focus remains localized and separated from the surrounding bone by a connective tissue membrane more or less pervaded by tubercles. Osteosclerosis is occasionally seen in the neighbourhood.

The osteous form is characterized by bony necrosis surrounded by a distinct zone of demarcation, thus giving rise to sequestrae within the necrotic foci.

KAUFFMANN distinguishes between a diffuse caseous internal osteitis beginning centrally in the vertebral body and a caries which arises cortically and is usually situated anteriorly in the vertebral body close to the intervertebral disc. SCHMORL and JUNGHANNS point out that tuberculosis generally begins in the periphery of the vertebral body beside the intervertebral disc which is soon gradually destroyed.

KREMER and WIESE mention that the intervertebral disc is early destroyed in tuberculous spondylitis and that the process soon extends

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over into the adjacent vertebral body. This is especially the case in children where the thinner peripheral zone of the vertebra does not limit the destructive process in the same way as in adults. The tuberculous process in children has therefore at an early stage involved two adjacent vertebrale while in adults it may not infrequently be limited to only one.

Tuberculous infection of the vertebra is believed to arise hematogenously. The wedge-shaped infarct-like foci have suggested direct occlusion by an embolus of bacillary material or else the development of a tuberculous endarteritis gradually leading to obliteration of the vascular lumen.

In diffuse osteitis it is imagined that the baccilli are caught in a somewhat smaller intra-osseous vessel and from there attack the neighbouring tissues.

According to SCHMORL there are no vessels in the healthy intervertebral disc of the adult. Therefore a primary infection cannot arise hematogenously at this site in adults. In children however where there are still blood vessels in the disc, it is possible to have a primary lesion in the disc. In the foetus BÖHMING and UBERMUTH have shown that three sets of vessels enter the intervertebral disc on the upper and lower surface. These vessels come from the adjacent vertebral bodies. They disappear after a few years so that the intervertebral disc lacks blood vessels when growth ceases.

The most thorough investigations of the vascular supply of the vertebrae have been carried out by LEXER and his collaborators. After injection of the vessels with a mercury contrast medium they removed different parts of the skeleton and dissected them. Röntgen photographs were then taken and the extent of the vessels within different portions of the skeleton could be studied.

According to LEXER and his coworkers there is a pair of arteries on the posterior surface of the vertebral body and these penetrate the body posteriorly. Another pair enters at the base of each transverse process. The former vessels supply the vertebral body and the latter the processes and arches. The body also receives a blood supply anteriourly through a number of small vessels which enter there. In general it is the posterior pair of vessels which is well developed and supplies the greater part of the vertebral body. Occasionally however these vessels are not so well developed and then the anterior vessels supply the greater portion of the vertebra.

LEXER's investigations show that it is the anterior lateral portion of the vertebral body which has the most profuse blood supply. Therefore an infection by means of an embolus would usually attack the anterior lateral section of the vertebral body.

I[XER]'s studies were however confined to foetuses. Our knowledge of th[e] vascular supply of the vertebrae in adults is still unsatisfactory as n[o] detailed examination has been done. We have therefore started an a[na]tomical and röntgenological investigation of the vascular supply of th[e] vertebrae in adults in order to discover if it is in any way differ[e]nt [f]rom that in foetuses. It seems probable to us that the vascularizatio[n] in adults is not as profuse as in the foetus. Such a difference woul[d] explain the different types of tuberculous spondylitis in children and [a]dults.

D[u]ring the years 1930—1936 we have had an opportunity to observe and [e]xamine repeatedly altogether 275 cases of tuberculous spondylitis. In 2 instances the process was l[i]mited to the arches, while in all th[e] other cases it was confined to th[e] vertebral bodies. In 25 cases (abou[t] 10 %) there have been multip[l]e widely separated lesions. In 10[8] cases the condition was relatively young with a short history and beginning lesions on the röntgen film. The other 167 cases showed more advanced changes. The 108 early cases have been the object of the present study.

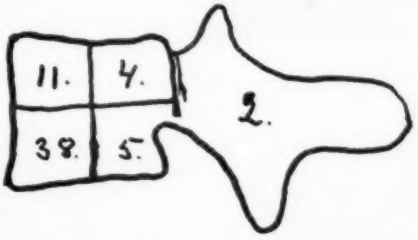


Fig. 1. Showing the site of the focal osteitis within the vertebrae.

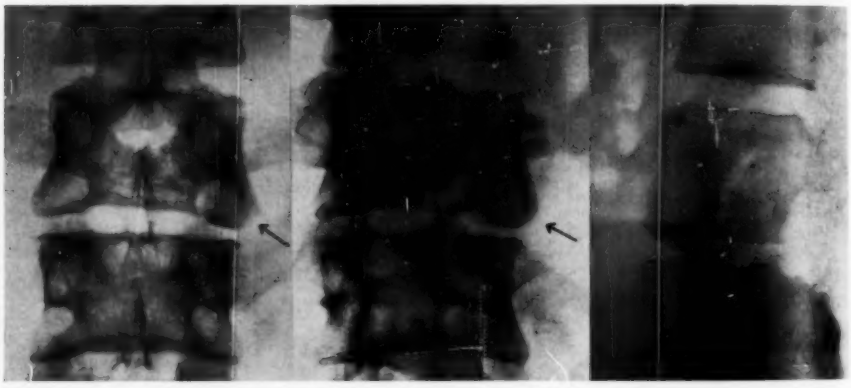
From a röntgenological standpoint we believe one can divide tuberculous spondylitis into a diffuse and a focal osteitis just as in the pathological classification.

60 cases showed at the first examination a well defined focus involving only a small portion of the vertebral body. 48 cases displayed at the first examination a diffuse osteitis affection the greater portion of the vertebral body.

As far as the site of the focal osteitis within the vertebral body is concerned (see Fig. 1), this was in the anterior lateral portion in 49 cases (in 38 of these in the anterior inferior lateral corner and in 11 in the anterior superior lateral corner). In 9 cases the focus was situated in the posterior lateral portions of the vertebral body (in 5 of these in the posterior inferior lateral corner and in 4 in the posterior superior lateral corner). In 2 cases the lesion was limited to the arches. It is thus obvious that focal osteitis in most instances is situated in the anterior lateral portion of the vertebral body and usually in its inferior corner. Diffu[s]e osteitis also seems in most cases to be located at an early stage in th[e] anterior portion of the vertebral body. In most cases however there soon occurs rather wide extension within the body of the vertebra.

a. b. c.

Fig. 2. Case 1. Case of focal osteitis surrounded by a definite osteosclerosis and periosteal deposits.



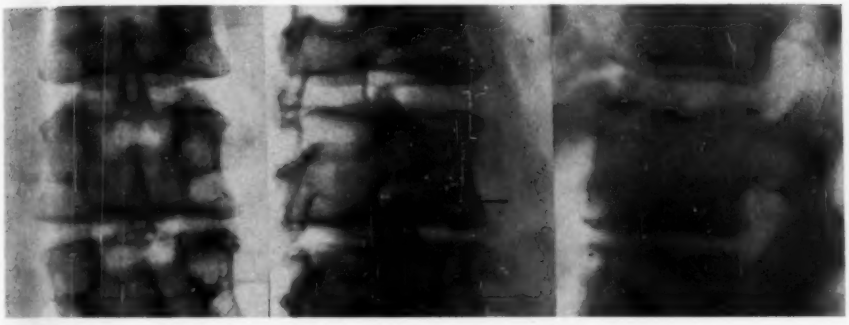
a. b. c.

Fig. 3. Case 1. Half a year later. The periosteal deposits have increased. The focus is better limited.

The age factor in tuberculous spondylitis is illustrated in the following table. Of 60 cases with focal osteitis no less than 56 were over 15 years of age and 46 were over 20. Diffuse osteitis however seems to occur more widely in young individuals. Of 48 such cases, 29 were less than 10 years of age and 36 were under 20 years. It is thus clear that

a. b. c.

Fig. 4. Case 2. Case of focal osteitis. Prominent periosteal deposits.



a. b. c.

Fig. 5. Case 3. Case of focal osteitis with an irregular sequestrum which contains more calcium then the adjacent bone.

focal osteitis is common more in adults and diffuse osteitis more frequent in children.

Table I

Showing the age factor in tuberculous spondylitis of diffuse and focal osteitis

Age	1—10	11—15	16—20	21—30	31—40	41—50	51—60	Summa
Diffuse osteitis	29	2	5	5	5	1	1	48
Limited focal osteitis . . .	2	2	10	29	10	4	3	60
Summa	31	4	15	34	15	5	4	108

a. b.

Fig. 6. Case 4. Case of diffuse osteitis with compression and gibbus formation.

a. b.

Fig. 7. Case 5. Case of diffuse osteitis with compression and gibbus formation.

We have been able to distinguish 2 different types of focal spondylitis. One form appears relatively early after the onset of symptoms. In this type the focus is limited at an early stage by a definite osteosclerosis and periosteal deposits in the immediate neighbourhood if the lesion lies close to the surface. This osteosclerosis and periostitis seem to decrease gradually during the later course and are not so marked or else have completely disappeared in the later stages. The focus appears as a rounded or irregular area of rarefaction in the vertebral body and

a. $^{6}/_{12}$ 1932. b. $^{25}/_{4}$ 1933. c. $^{20}/_{9}$ 1933.

Fig. 5. Case 6. Case of diffuse osteitis with compression and gibbus formation. At the first examination calcium deposits in the surrounding of the destruction. The calcium deposits later decreases.

is surrounded by a sclerotic border zone. Sometimes it is possible to distinguish fine bony gravel in the cavity.

The other type appears later on the röntgen picture, frequently not until the intervertebral disc has been more or less destroyed. Such a focus is characterized by a rounded or irregular sequestrum which contains more calcium than the adjacent bone. There thus arises a rarified border zone around the sequestrum. In the neighbourhood of this zone there is a mild perifocal increase in calcium during one phase of the early stages. This diminishes later.

Diffuse osteitis is generally discovered relatively late on röntgen pictures and not until there is compression with gibbus formation. This is due to the circumstance that the destruction very rapidly infiltrates the greater part of the vertebral body usually in its anterior portion. The compression produces a wedge-shaped vertebra. Within the area of destruction it is often possible to distinguish a number of irregular small sequestrae and pieces of gravel. At a very early stage the adjacent vertebrae are also attacked and the intervertebral discs are destroyed. In many cases however the process can be limited by a definite zone of demarcation towards the vertebral surface above and below. This perifocal increase in calcium content diminishes in later stages.

The foregoing thus shows that one is generally un-successful in diagnosing diffuse osteitis at an early stage. It usually does not show up on the röntgen picture until there are large areas of destruction with compression and gibbus formation. It is possible however to make a röntgen diagnosis of focal tuberculous spondylitis in a relatively early stage, before the destructive process has extended and led to compression and gibbus formation. On account of the above-mentioned loca-

lization of the foci it is valuable for röntgen diagnosis to take pictures with the rays directed obliquely, in addition to the usual frontal and lateral views of the vertebral column. The most suitable technique is with the rays at about an angle of 45° towards the vertebrae. On such pictures the foci usually show up best and it is easy to observe whether osteosclerosis and periostitis are present.

SUMMARY

The tuberculous spondylitis can from roentgenological point of view be divided into one focal and one diffuse osteitis. The focal osteitis is more common in adults and the diffuse osteitis is more frequent in children.

One can distinguish 2 different types of focal spondylitis. One type is limited at an early stage by a definite osteosclerosis and periosteal deposits and the other is characterized by a rounded or irregular sequestrum and a rarified border zone.

The focal spondylitis of both types is most often localized to the anterior lateral border of the vertebral body. The focal spondylitis can be diagnosed roentgenologically at an early stage while the diffuse spondylitis is discovered roentgenologically relatively late.

ZUSAMMENFASSUNG

Die tuberkulöse Spondylitis lässt sich vom röntgenologischen Standpunkt in eine fokale und eine diffuse Osteitis einteilen. Die fokale Osteitis kommt häufiger bei Erwachsenen vor, die diffuse Osteitis ist bei Kindern häufiger.

Bei der fokalen Spondylitis sind 2 verschiedene Typen zu unterscheiden. Ein Typ ist in einem frühen Stadium von einen zirkumskripten Osteosklerose und von periostalen Auflagerungen umgegeben, der andere ist durch einen rundlichen oder unregelmässigen Sequester und eine rarefizierte Randzone charakterisiert.

Die fokale Spondylitis beider Typen ist am häufigsten im vorderen lateralen Rande des Wirbelkörpers lokalisiert. Sie kann röntgenologisch in einem frühen Stadium diagnostiziert werden, während die diffuse Spondylitis relativ spät röntgenologisch entdeckt wird.

RÉSUMÉ

La spondylite tuberculeuse peut, au point de vue roentgenologique, se diviser en une ostéite focale et une ostéite diffuse. La première est plus commune chez les adultes, tandis que la seconde est plus fréquente chez les enfants.

On peut distinguer 2 types différents de spondylite focale. L'un d'eux est limité à un stage précoce par une nette ostéosclérose et par des dépôts péri-ostéaux, et l'autre est caractérisé par un séquestre arrondi ou irrégulier et une zone frontière rarifiée.

La spondylite focale des deux types est le plus souvent localisée à la limite antérieure latérale du corps de la vertèbre. La spondylite focale peut être diagnostiquée roentgenologiquement à un stage précoce, tandis que la spondylite diffuse ne se découvre roentgenologiquement que relativement tard.

AUS DER RÖNTGENABTEILUNG D. MARIAKRANKENHAUSES.
CHEF: DR. MED. ÅKE ÄKERLUND

ÜBER TRANSPARENTE GASHALTIGE SPALTBILDUNGEN IN GALLENSTEINEN UND IHRE RÖNTGENDIAGNOSTISCHE BEDEUTUNG[1]

von

Åke Åkerlund

Als allgemeine Regel gilt, dass die Gallensteine unter den beim Lebenden geltenden Verhältnissen wenigstens ebenso schwer sind wie die physiologische Nativgalle (und oft bedeutend schwerer sein können, als diese — selbst bei starker Konzentration — ist). Die Gallensteine haben, ziffermässig ausgedrückt, unter vitalen Verhältnissen im allgemeinen ein spezifisches Gewicht von *mindestens* 1,040, welche Ziffer die *obere* Grenze des spez. Gewichtes der Nativgalle unter physiologischen Verhältnissen angibt und gleichzeitig das spez. Gewicht des reinen Cholesterins ausdrückt. Bei Sedimentierungsproben von Gallenblaseninhalt unmittelbar nach Eröffnung der Gallenblase findet man deshalb fast immer die Gallenkonkremente als Bodensediment, auch wenn die Galle stark konzentriert ist.

Im Laufe von vielen Jahren habe ich zahlreiche Bestimmungen des spezifischen Gewichtes von Gallensteinen unter vitalen Verhältnissen gemacht, d. h. so lange sie sich im frischen, ungetrockneten Zustande befanden, unmittelbar nach dem Aufschneiden der Gallenblase. Die Gallensteine wurden direkt nach Herausnahme in eine Kochsalzlösung gebracht, die gerade so viel verdünnt worden war, dass der betreffende Gallenstein sich frei schwebend in der Lösung halten konnte, worauf das spezifische Gewicht der Lösung mit einem gewöhnlichen Urometer bestimmt wurde.

Bei diesen Bestimmungen des spezifischen Gewichtes habe ich nur in einigen seltenen Ausnahmefällen Gallensteine angetroffen, deren spezi-

[1] Vortrag, gehalten am 9. Nordischen Röntgenkongress in Kopenhagen am 29. Juni 1938

Fig. 1. Fall I. Perorale Cholezystographie. Sedimentierungsbild in stehender Stellung. Halbmondförmiges Fundussediment, darüber eine zentimeterhohe Schicht von Kontrastgalle, und oberhalb von dieser eine hohe Schicht von »schwimmenden» Konkrementen, die die ganze obere Hälfte der Gallenblase ausfüllten.

Fig. 2. Derselbe Fall. Neuerliche perorale Cholezystographie zeigte unveränderte Sedimentierungsverhältnisse. In den Konkrementen des Fundussediments wurden an mehreren Stellen dichtere Zentren unterschieden, und in den »schwimmenden» Konkrementen markierten sich auf dem Originalbilde an mehreren Stellen sternförmige zentrale Aufhellungen.

fisches Gewicht niedriger war als 1,040 (das sp. Gew. des reinen Cholesterins), nämlich bis 1,020 resp. 1,010 hinunter.

Da das in diesen Fällen aussergewöhnlich niedrige spezifische Gewicht der Gallensteine seine Erklärung in einem bisher unbeachteten Verhalten hat, und da dieses Verhalten sich sowohl *direkt* als auch *indirekt* auf dem Röntgenbilde zu erkennen geben kann und dann auch für die Röntgendiagnostik verwertbar wird, will ich über einige solche Fälle berichten, und gehe hier sofort darauf über.

Der *erste Fall* betraf eine Frau in mittleren Jahren, die 8 Jahre lang typische Gallensteinanfälle gehabt hatte. Bei *oraler Cholezystographie* wurde die Gallenblase bis zum gewöhnlichen Dichtigkeitsgrade mit Kontrast gefüllt. In der Gallenblase markierte sich eine grosse Anzahl von Defekten meist kleinerer Dimensionen, bei Sedimentierungsbildern

in tehender Stellung (Fig. 1) *verteilten die Ko kremente sich in zwei Schichten*, die durch ein ungefähr zentimeterbreite konkrementfre Region der Kontrastgalle voneinander get nnt waren: die untere Gruppe bildete ein halbmondförmiges Fundussediment, die ob e Gruppe füllte den mittleren und oberen Te der Gallenblase in Form einer zusammehängenden, mehrere Zentimeter hohen, »sc wimmenden» Konkrementschicht aus, die sich vom oberen Rande der Kontrastsch ht bis in den Gallenblasenhals hinauf ers eckte.

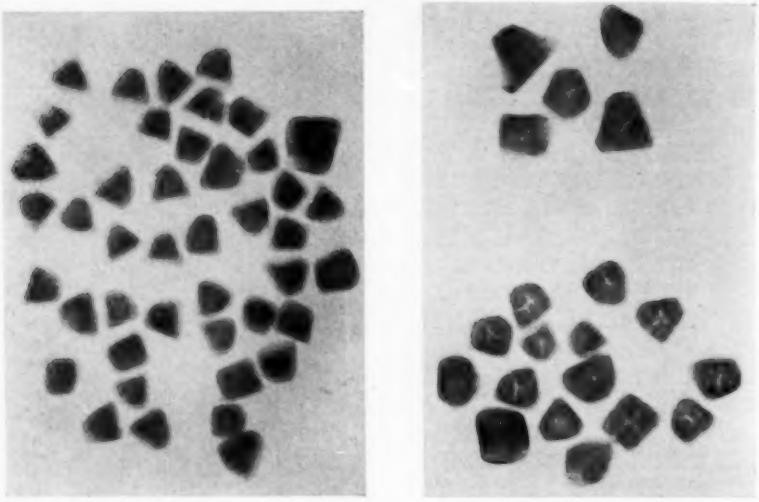
Nach ein paar Wochen wurde die orale Cho ezystographie wiederholt (Fig. 2). Trotzdem die Kontrastgalle diesmal bedeutend weniger konzentriert war als bei der ersten Untersuchung, waren die Konkremente in derselben bemerkenswerten Weise wie vorher *in zwei Gruppen angeordnet*, ein Fundussediment und eine auf der Oberfläche der Kontrastgalle schwimmende hohe Konkrementschicht. Infolge der dünneren Beschaffenheit der Kontrastfüllung konnte man bei dieser Gelegenheit dichtere Zentren in den Konkrementen des Fundussediments nachweisen, während wenigstens mehrere von den *Konkrementen in der schwimmenden Schicht kleine zentrale Aufhellungen zeigten.*

Fig. 3. Derselbe Fall. Sedimentierungsbild des Gallenblasenpräparates, unmittelbar nach der Cholezystektomie. Die Konkremente des Fundussegmentes zeigten dichtere Zentren. Die darüber in verschiedenen Höhen »schwimmenden» Konkremente wiesen deutliche sternförmige zentrale Aufhellungen auf.

Einige Wochen später wurde *Cholezystektomie* vorgenommen (Dr. S. Rödén). Unmittelbar danach erfolgte eine röntgenologische Sedimentierungsuntersuchung des unaufgeschnittenen Gallenblasenpräparates (Fig. 3).

Am Fundus fand sich ein grosses Bodensediment von etwas kleineren Konkrementen, und in mehreren von diesen konnte man dichtere Zentren unterscheiden. Oberhalb vom Bodensediment schwammen in der Nativgalle auf verschiedenen Höhen mehrere etwas grössere Konkremente, und in allen diesen schwebenden Konkrementen wurden mehr oder weniger deutliche, feine, transparente, sternförmige Aufhellungen beobachtet.

Nachdem die Nativgalle durch Punktion entfernt worden war, wurde ihr spezifisches Gewicht auf etwa 1,023 bestimmt. Für einen Versuch zur Rekonstruktion der Verhältnisse bei der Cholezystographie wurde eine geringe Menge Jodtetragnost zur Nativgalle zugesetzt, wodurch



4 a. 4 b.

Fig. 4. a. u. b. Derselbe Fall. Röntgenbild von sämtlichen Konkrementen, unmittelbar nach Aufschneidung der Gallenblase. a) *Alle* Konkremente des Fundussediments (43 an der Zahl) hatten mehr oder weniger verdichtete Kerne und ein spez. Gewicht von 1,066—1,072. b) *Sämtliche* (20) »schwimmenden» Konkremente wiesen eine sternförmige zentrale Aufhellung auf, 15 von ihnen hatten ein spez. Gewicht von 1,023—1,035 und 5 ein spez. Gewicht von 1,010—1,020.

sich deren spez. Gewicht auf 1,036 erhöhte. Danach wurde diese Kontrastgalle mittels einer Punktionsspritze wieder in die auch weiterhin unaufgeschnittene Gallenblase gebracht, worauf ein neues röntgenologisches Sedimentierungsbild aufgenommen wurde. Dieses zeigte völlige Übereinstimmung mit der Cholezystographie: es fand sich wieder dieselbe Aufteilung der Konkremente in ein Bodensediment und eine schwimmende Konkrementschicht, und die beiden Gruppen waren durch eine von Konkrementen freie Kontrastgallenschicht getrennt. Das Bodensediment bestand aus Konkrementen mit mehr oder weniger dichten Zentren, *die schwimmende Kontrastschicht bestand aus Steinen mit feinen sternförmigen zentralen Aufhellungen.*

Nach dem Aufschneiden der Gallenblase wurden sofort die spezifischen Gewichte der einzelnen Gallensteine bestimmt. Die Konkremente im Bodensediment (43 an der Zahl) mit mehr oder weniger deutlichen, dichteren Zentren hatten ein spezifisches Gewicht, das zwischen 1,066 und 1,072 variierte, sie waren also deutlich schwerer als reine Cholesterinsteine. *Die in der schwimmenden Konkrementschicht befindlichen Kon-*

Fig. 5. Fall II. Keine Kontrastfüllung der Gallenblase nach doppelter peroraler Kontrastadministration. Oben rechts auf dem Bilde ein grosser kalkhaltiger Gallenstein in der Gegend des Gallenblasenhalses. Unten links entsprechend dem Gallenblasenfundus eine Anzahl sternförmiger transparenter Aufhellungen, entsprechend den zentralen Teilen einer weiteren Anzahl von Konkrementen.

kremente mit zentraler Aufhellung — insgesamt 20 Stück — hatten alle ein spezifisches Gewicht von weniger als 1,035. Fünf von diesen schwimmenden Konkrementen hatten sogar ein spezifisches Gewicht zwischen 1,010 und 1,020. Eine unmittelbar ausgeführte *Röntgenaufnahme aller ungetrockneten Konkremente* (Fig. 4a und b) zeigte, *dass alle diese, die in ihrer Schicht »schwammen», durchsichtige Spaltbildungen hatten, während in den Konkrementen des Fundussedimentes solche fehlten*, die Mehrzahl der letzteren wies anderseits verdichtete Zentren auf. Nachdem die Konkremente 24 Stunden lang getrocknet hatten, waren die Spaltbildungen auf einer neuaufgenommenen Röntgenphotographie kaum deutlicher. Auf der Oberfläche der Konkremente wurden weder in frischem noch in getrocknetem Zustande Spaltbildungen beobachtet.

Der *zweite* Fall betraf eine ältere Dame, die in den letzten zwei Jahren

Fig. 6. Derselbe Fall. Besonders deutlich markiert sich unten in der linken Ecke des Bildes, entsprechend dem Fundus, eine dreistrahlige sternförmige Aufhellung, deren Zentrum durch einen kleinen schwarzen Punkt ausgezeichnet ist.

an kolikartigen Schmerzen im oberen Teile des Bauches gelitten hatte, die nicht von der Art typischer Gallensteinschmerzen waren.

Bei der *Röntgenuntersuchung* (Fig. 5, Fig. 6) wurde keine Kontrastfüllung der Gallenblase erhalten, und als Erklärung für diese mangelhafte Gallenblasenfüllung markierte sich nächst dem unteren Leberrande, an einer Stelle, die gut dem Gallenblasenhalse entsprach, ein etwas eckiger, ungefähr 1-Kronengrosser Ringschatten, der die Röntgendiagnose grosser kalkhaltiger Stein im Blasenhalse motivierte. Im Korpus und Fundus der Gallenblase erhielt man einen undeutlichen Eindruck von einigen äusserst dünnen Kalkschollen auf einer Anzahl facettierter Konkremente. *Der Konkrementcharakter* dieser unsicheren Schatten *wurde durch das Vorhandensein transparenter drei- bis vierstrahliger Sternbildungen in mehreren von den Konkrementen bewiesen.* Besonders schön sah man auf sämtlichen Bildern ein klar transparentes dreistrahliges Sterngebilde in einem grösseren Konkrement in nächster Nähe des Fundus hervortret;

Fig. 7. Derselbe Fall. Röntgenphotographie der Gallenblase, unmittelbar nach der Exstirpation. Das kalkhaltige Konkrement liegt jetzt im Zentrum der Gallenblase. Rund herum davon eine Anzahl kleinere Konkremente, die meisten mit deutlichen zentralen sternförmigen Aufhellungen.

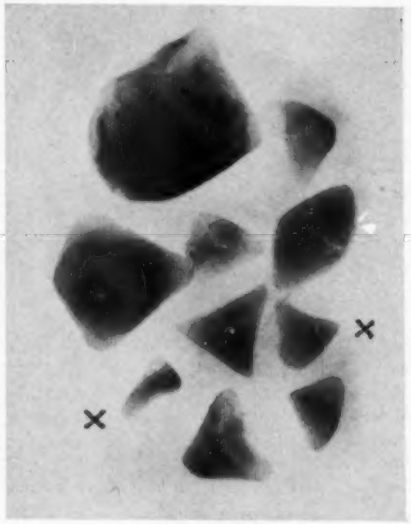


Fig. 8. Derselbe Fall. Röntgenbild der Gallensteine unmittelbar nach Herausnahme aus der Gallenblase. Das grössere kalkhaltige Konkrement hatte ein spezifisches Gewicht von mehr als 1,080. Von den 9 nicht kalkhaltigen Konkrementen wiesen 7 deutliche zentrale transparente Spaltbildungen auf und hatten ein spez. Gewicht von 1,023—1,035. Nur zwei von diesen kleineren Konkrementen (auf dem Bilde mit »x» bezeichnet) wiesen keine Spaltbildungen auf, und beide hatten ein spez. Gewicht von 1,055.

das Zentrum des Sternes fiel mit dem des Konkrementes zusammen, und die drei Strahlen waren deutlich bis hinaus zur schmalen, leicht verdichteten Oberflächenschicht zu verfolgen. Die Sternbildung war bedeutend durchscheinender als die übrige Gallenblase und als die ganze Umgebung, und die Transparenz wurde nur vom Grade der Durchsichtigkeit des gashaltigen Inhalts einiger benachbarten Darmschlingen übertroffen.

Bei Operation (Doz. J. HELLSTRÖM) wurde die Röntgendiagnose in allen Teilen verifiziert. Die exstirpierte Gallenblase wurde unmittelbar unaufgeschnitten röntgenphotographiert (Fig. 7) und zeigte in der Mehrzahl der facettierten Konkremente sternförmige Spaltbildungen. Nach der

Fig. 9. Fall III. Perorale Cholezystographie; Sedimentierungsbild in stehender Körperstellung. Oberhalb der Kontrastgalle »schwammen» 8 haselnussgrosse Konkremente, welche die obere Hälfte der Gallenblase ausfüllten. Auf den Originalbildern waren in allen diesen Konkrementen sternförmige, zentrale Aufhellungen zu sehen.

im unmittelbaren Anschluss vorgenommenen Aufschneidung der Gallenblase wurde sofort ein neues Röntgenbild der Konkremente aufgenommen (Fig. 8), das schön den grossen kalkhaltigen Stein ohne transparente Spaltbildungen und 9 facettierte kleinere Konkremente zeigte, 7 davon mit transparenten Spaltbildungen und 2 ohne solche. Danach wurde sofort das spez. Gewicht sämtlicher 9 facettierten Steine in ungetrocknetem Zustande bestimmt. Dabei zeigte sich, dass nur die zwei von den Konkrementen, die keine Spaltbildungen aufwiesen, ein spez. Gewicht von 1,055 hatten: die übrigen sieben, die sämtlich grössere oder kleinere Spaltbildungen zeigten, hatten ein zwischen 1,023 und 1,035 variierendes spez. Gewicht. Der grosse kalkhaltige Stein hatte ein bedeutend höheres spez. Gewicht als 1,080.

Der *dritte* Fall betraf eine jüngere Frau, die ungefähr seit 1 Jahr unangenehme Empfindungen in der Gallenblasengegend gefühlt hatte, die nur ein Mal den Charakter eines wirklichen Schmerzanfalls bekamen.

Bei *Röntgenuntersuchung* füllte sich eine normalgrosse Gallenblase mit Kontrast, und in diesem markierten sich 8 haselnussgrosse Konkrementdefekte, *alle mit einer zentralen, transparenten, sternförmigen Spaltbildung*. Auf Sedimentierungsbildern (Fig. 9) sammelten sich sämtliche Konkremente so hoch oben in der Gallenblase, wie der Raum es erlaubte, oberhalb der Kontrastgalle schwimmend, was für ein auffallend niedriges spez. Gewicht der Konkremente sprach.

Unmittelbar nach der Operation (Dr. W. Bohm) wurde erst ein Röntgenbild der unaufgeschnittenen Gallenblase gemacht (Fig. 10), das die transparenten Spaltbildungen in allen Steinen schön demonstrierte. Bei unmittelbarer Bestimmung des spez. Gewichtes der Gallensteine,

bevor diese eintrocknen konnten, zeigte sich, daß dieses bei *einem* der Steine 1,021 betrug, bei *fünf* 1,023 und bei *zweien* 1,029.

Es handelt sich hier also um drei Fälle von Cholelithiasis, wo mehrere Gallenkonkremente ein bedeutend niedrigeres spezifisches Gewicht hatten als gewöhnlich, ein Gewicht, das sogar kleiner war als das der leichtesten, reinen Cholesterinkonkremente. *Als Ursache für dieses niedrige spezifische Gewicht wurden* sowohl bei der Röntgenuntersuchung am Lebenden als auch auf den sofort nach Aufschneidung der Gallenblase gemachten Röntgenbildern der ungetrockneten Konkremente *transparente sternförmige Spaltbildungen nachgewiesen.* Solche Spaltbildungen wurden ausnahmslos in allen beobachteten leichten Gallenkonkrementen festgestellt und fehlten in den normalschweren.

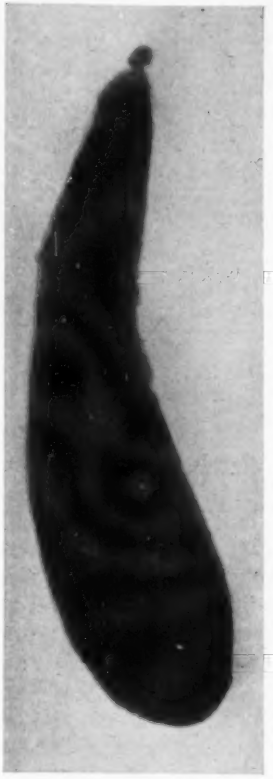


Fig. 10. Derselbe Fall. Röntgenphotographie der Gallenblase, unmittelbar nach der Herausnahme, zeigte in sämtlichen Konkrementen transparente Spaltbildungen. Das spez. Gewicht der Konkremente betrug 1,021—1,029.

Spaltbildungen in Gallensteinen waren seit langem bekannt und in der pathologisch-anatomischen Literatur abgebildet (Fig. 11 a und b, Fig. 12). Schon MECKEL VON HEMSBACH hatte solche im Jahre 1856 in seiner »Mikrogeologie» beschrieben. MECKEL VON HEMSBACH unterschied die Zentralhöhle und die radiären Spalten und war der Ansicht, dass die Zentralhöhle durch eine Aufweichung (Emollition) der zentralen Partie der Steine entstanden sei.

Von neueren Verfassern hat besonders der Däne J. BOYSEN die Spaltbildung in seiner Doktorsdissertation vom Jahre 1900 genauer studiert. Er hielt sie für eine sekundäre Veränderung in facettierten Steinen und wies darauf hin, dass die Spalten gegen das Zentrum hin breiter wären als in der Peripherie; die Zentralhöhle betrachtete er nur als zentrale, zusammenstossende Partien der Spaltbildungen. Die Lage der Spalten stand immer in einer gewissen Beziehung zur Form der Steine und sie folgten immer den kürzesten Radien. BOYSEN hält die Spaltbildung für das Resultat einer zentrifugalen Schrumpfung der Steine, welche Schrumpfung durch die albuminoide Substanz hervorgerufen würde, die eine zusammenhängende organische Struktur in den Konkrementen bilde. BOYSEN wies darauf hin, dass diese spaltförmigen Hohlräume nicht

a. b.

Fig. 11. a. u. b. Schleifpräparat mit sternförmigen zentralen Spaltbildungen (nach BOYSEN).

durch Trocknung der Gallensteine in der Luft verursacht seien, sondern in Gallensteinen vorlägen, die direkt aus der Gallenblase herausgenommen und dann unter Wasser aufbewahrt worden waren. Über den Inhalt im System der Hohlräume habe ich bei BOYSEN nur die Angabe gefunden, dass die Zentralhöhle oft von einer zusammenhängenden Masse von unregelmässig angeordneten Cholesterinblättchen ausgefüllt ist, und dass zwischen den Blättchen und nach aussen zur Peripherie der Spalten hin oft verstreute Pigmentreste vorkommen.

NAUNYN (1921) äusserte die Ansicht, dass der zentrale Hohlraum in den Gallensteinen früh entsteht, während das Innere des Steines noch weich ist. Weil die äussere Schicht des Steines dann schon fest ist, kann sich der Stein nicht mehr im ganzen zusammenziehen. Die festeren Bestandteile des Kernes lagern sich an der festen Rinde ab *und in dem Hohlraum*, der im Zentrum entsteht, *sammelt sich Flüssigkeit*, die nach NAUNYN in frischen Steinen $^1/_2$ kbcm ausmachen könne. Bei Analyse erwies sie sich als »wasserklar, fast völlig gehaltlos, enthält kein Eiweiss, keinen Schleim, etwas Chlornatrium, Spuren von Kalk und Cholesterin». In vielen Fällen wird der zentrale Hohlraum später durch »Cholesterinierung» ausgefüllt, es bleibt aber eine Narbe zurück, welche die frühere Ausbreitung des Hohlraumes andeutet. NAUNYN wies schliesslich darauf hin, dass bei Trocknung von Gallensteinen mit weichem Kern nach Herausnahme aus der Gallenblase Hohlräume entstehen können, die man schwer von den beim Lebenden vorkommenden zu unterscheiden vermag.

Auch ein Schüler ASCHOFFS, TORINOUMI, der 1923—24 die Entstehung des zentralen »Naunynschen Hohlraumes» als ein unzweifelhaft kolloidchemisches Problem, als einen »Entquellungsprozess» auffasste, hob hervor, dass *der zentrale Hohlraum mit Flüssigkeit gefüllt* sei. »Infolge der

Unnachgiebigkeit der äusseren dichten Schalen führt dieser Entquellungsprozess schliesslich zur Selbstzerreissung der Kernstruktur, zum Auftreten der Spalten, die sich mit dem Entquellungswasser füllen.»

Sowohl TORINOUMI als auch KROGIUS wiesen ungefähr gleichzeitig darauf hin, dass das Vorkommen eines sternförmigen Hohlraumes in vielen Gallensteinen das Eintreten von *spontanem Zerfall der Steine* in kleinere Bruchstücke begünstige, und beide haben unzweideutige Beweise dafür angeführt, dass eine solche *Selbstsprengung* vorkommt. Nach KROGIUS ist diese Selbstsprengung »eine ganz gewöhnliche Erscheinung, die offenbar in der Genese der sogenannten multiplen facettierten Steine eine nicht unwesentliche Rolle spielt».

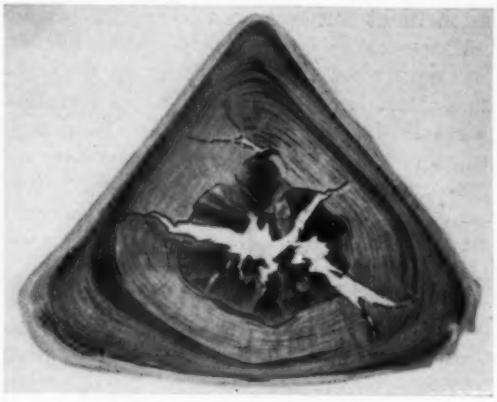


Fig. 12. Schleifpräparat von einem geschichteten Gallenstein mit sternförmiger Spaltbildung (nach TORINOUMI).

Bei keinem einzigen Verfasser gelang es mir, eine Angabe darüber zu finden, dass die sternförmigen Spaltbildungen im Inneren der Gallensteine unter vitalen Verhältnissen gasförmige Stoffe enthielten. Die Erklärung hierfür dürfte in der bisher bei diesen Studien üblichen Untersuchungstechnik liegen, die darauf hinausging, dünne Schleifpräparate durch die Konkremente zu erhalten, welche Präparate sodann bei grösserer oder kleinerer Vergrösserung bei durchfallendem und auffallendem Licht dem Studium unterzogen wurden.

Soweit mir bekannt ist, hat die intravitale Spaltbildung in den Gallensteinen bisher kaum grösseres röntgenologisches Interesse auf sich gezogen. Ich habe nur einen einzigen hierhergehörenden kurzen kasuistischen Beitrag in der röntgendiagnostischen Literatur gefunden. BÉLA BREUER in Budapest schilderte 1931 in der *Röntgenpraxis* einen solchen Fall, wo man bei einer Nachprüfung der Röntgenbilder nach vorgenommener Operation einige sternförmige Aufhellungen im Gallenblasengebiete beobachtete, die vollständig mit den Spaltbildungen übereinstimmten, die auf Röntgenbildern der herausgenommenen Steine und bei Betrachtung von Schnitten aus diesen beobachtet wurden. BREUER ging nicht auf eine nähere Erklärung darüber ein, wie diese Spaltbildungen sich bei der Röntgenuntersuchung des Patienten markieren konnten, und

auch nicht auf die Frage des Inhaltes der Hohlräume unter vitalen Verhältnissen.

Meiner Ansicht nach kann man nicht umhin, bei solchen Fällen, wo sich beim Lebenden das System von Hohlräumen röntgenologisch markiert hatte, *gasförmigen Inhalt in dem zentralen sternförmigen Zentralraum anzunehmen.* Auf andere Weise, scheint mir, kann unmöglich die grosse Transparenz erklärt werden, welche die Spaltbildungen nicht nur im Verhältnis zum ganzen übrigen Galleninhalt kennzeichnet, sondern auch im Verhältnis zum Dichtigkeitsgrade der benachbarten Bauchorgane. Den entscheidenden Beweis für meine hier vorgebrachte Auffassung betreffs eines gasförmigen Inhaltes dieser sternförmigen Spaltbildungen habe ich im aussergewöhnlich niedrigen spezifischen Gewicht dieser Gallensteine erhalten, das bedeutend unter demjenigen der reinsten Cholesterinsteine liegt, weshalb diese Konkremente nicht auf den Boden sinken, sondern schon in mässig konzentrierter Nativgalle obenauf schwimmen. Die spezifischen Gewichte, die ich in meinen Fällen bei diesen Konkrementen mit transparenten Spaltbildungen beobachtete, hielten sich zwischen 1,010—1,035.

Woran es liegt, dass der in gewöhnlichen Fällen sicher flüssige Inhalt der Spaltbildungen in gewissen Fällen gashaltig wird, war ich nicht in der Lage, näher zu untersuchen. *Die nächstliegende Erklärung dürfte wohl in Zersetzungsprozessen zu suchen sein, die durch gasbildende Bakterien oder auf andere Weise entstehen.* Die Bildung der Hohlräume in den Gallensteinen an sich ist sicher eine relativ gewöhnliche sekundäre Veränderung. Dass man unter vitalen Verhältnissen so relativ selten transparente Sternbildungen in Gallensteinen nachweisen kann, und dass man ebenso selten bei Bestimmung des spezifischen Gewichtes frischer Gallensteine solche antrifft, die leichter sind als die Gallenblasengalle, spricht dafür, dass die Flüssigkeitsansammlung in diesen Hohlräumen der Gallensteine nur relativ selten in höherem Grade durch gasförmigen Inhalt ersetzt ist.

Jedenfalls ist dieses Verhalten wert, von den Röntgendiagnostikern im Gedächtnis behalten zu werden. Wenn die Erscheinung auch nicht besonders häufig ist, so enthält sie doch die Erklärung für *ein neues Röntgensymptom bei Cholelithiasis* (*das Symptom der »transparenten Gallensteinspalten»*), das die Gallensteindiagnose in Fällen ermöglichen kann, wo die Konkremente auf keine andere Weise röntgenologisch nachgewiesen werden konnten, und enthält auch die Erklärung für die abweichenden Sedimentierungsverhältnisse, welchen der Röntgenolog mitunter begegnen kann, der die Röntgendiagnostik von Gallenkonkrementen durch intravitale Sedimentierungsuntersuchungen des Gallenblaseninhaltes zu verfeinern versucht.

Stockholm, Mai 1938.

Nachschrift

Nachdem der obige Vortrag am 9. Nordischen Röntgenkongress in Kopenhagen im Juni 1938 gehalten worden war, haben KOMMERELL und WOLFERS von der 1. med. Universitätsklinik an der Charité in Berlin einerseits eine kurze vorläufige Mitteilung in der *Klinischen Wochenschrift vom 6. Aug. 1938*, anderseits einen Artikel im *Augustheft der Fortschritte a. d. Geb. d. Röntgenstrahlen, Vol. 58, S. 156* publiziert, beide mit dem Titel: Gashaltige Gallensteine. Die Verfasser haben in 5 Fällen bei Röntgenuntersuchung in vivo sternförmige zentrale Aufhellungen in den nachgewiesenen Gallensteinen beobachtet; zwei von den Fällen kamen zur Operation. In einem von diesen Fällen konnte man bei Zerbrechen eines gashaltigen Steines unter Wasser das Entweichen der Gasblasen direkt beobachten. Die Gasanalyse ergab: »0,5 % Sauerstoff, 6—7,5 % Kohlensäure. Der Rest war nicht brennbares Gas.» Die Verff. teilen die Auffassung, der in meiner obigen Arbeit Ausdruck gegeben ist, nämlich dass das Gas wahrscheinlich durch Zersetzungsprozesse entsteht, vielleicht bei der Tätigkeit von Mikroorganismen.

ZUSAMMENFASSUNG

Sternförmige Spaltbildungen in Gallensteinen kommen nicht nur bei getrockneten Exemplaren der Präparatsammlungen vor, sondern auch in ziemlich grossem Ausmasse schon beim Lebenden, wobei sie im allgemeinen mit Flüssigkeit gefüllt sind, oder halbflüssigen Inhalt haben, und sich röntgenologisch nicht von den Geweben des Körpers differentiieren. Röntgendiagnostisches Interesse bekommen diese Spaltbildungen nur in den relativ seltenen Fällen, wo sie entweder direkt infolge ihrer auffallenden Transparenz auf dem Röntgenbilde hervortreten oder eine Herabsetzung des spezifischen Gewichtes der Gallensteine herbeiführen, die sich bei röntgenologischen Sedimentierungsuntersuchungen zu erkennen geben kann. *Sowohl die grosse Transparenz der Spaltbildungen* auf dem Röntgenbilde *als auch das* in allen Fällen vorliegende *abnorm niedrige spezifische Gewicht der Konkremente*, das in frischem Zustande bestimmt wurde, und in meinem Material zwischen 1,010—1,035 variierte (also durchwegs sogar niedriger war als das spez. Gewicht des reinen Cholesterins) *zeigen, dass die Spaltbildungen in solchen seltenen Fällen gasförmige Stoffe enthalten*, die wahrscheinlich von gasbildenden Bakterien oder von anderen Zersetzungsprozessen stammen.

Die *»transparenten Sternspalten»* in der Gallenblasenregion sind bisher in der Röntgendiagnostik wenig beachtet worden, und die Ursache für das Auftreten *dieses neuen Röntgensymptoms* war bisher nicht klargelegt. Die gasgefüllten Spaltbildungen in den Gallensteinen können, wenn sie auch seltene Befunde sind, eine Gallensteindiagnose in gewissen Fällen ermöglichen, wo die Konkremente selbst auf keine andere Weise röntgenologisch nachgewiesen werden konnten.

SUMMARY

Star-shaped fissures in gall stones occur not only in dried specimens but also quite extensively during life when they usually contain fluid or semi fluid material and do not

roentgenologically stand out against the tissues of the body. These cracks are of roentgenological interest only in the relatively rare cases where they are directly evident on the roentgen film due to striking transparency or when they bring about a decrease in the specific gravity of the concrement, a feature which comes to light in roentgenological sedimentation examinations. Both the great roentgenological transparency of the fissures and the low specific gravity of the stones as estimated on the fresh specimen (varying in my material between 1,010 and 1,035 and thus being lower than even the specific gravity of pure cholesterin) showed that in such rare cases the cracks contain gaseous substances probably arising from gas-producing bacteria or from other disintegration processes.

These »transparent star-like fissures» in the gall bladder region have up to the present attracted very little attention in roentgen diagnosis and the cause of the occurrence of this new roentgen sign has never before been explained. However, gas-filled fissures within a gall stone, even if they are rare, may in certain cases make possible a diagnosis of gall stone when the concrement itself cannot be roentgenologically verified in any other way.

RÉSUMÉ

Les fêlures stelliformes dans les calculs biliaires n'apparaissent pas seulement sur les exemplaires desséchés des collections de préparations, mais, déjà, dans une assez large mesure, à l'état vivant, où elles sont généralement remplies de liquide ou ont un contenu mi-liquide, et ne se différencient pas, roentgenologiquement, des tissus du corps. Ces fêlures ne présentent un intérêt roentgendiagnostique que dans les cas, relativement rares, où elles, ou bien se détachent directement sur le cliché roentgen en raison de leur transparence frappante, ou bien amènent une diminution du poids spécifique des calculs, pouvant apparaître lors d'examens de sédimentation roentgenologiques. La *grande transparence des fêlures* sur le cliché roentgen, *de même que le poids spécifique anormalement faible des concrétions dans la totalité des cas*, déterminé à l'état frais (et ayant varié, dans ma matière d'études, de 1,010 à 1,035 poids spécifique, par conséquent, partout plus faible même que celui de la cholestérine pure) *démontrent qu'en de tels rares cas, les fêlures contiennent des matières gazeuses*, provenant vraisemblablement de bacilles gazogènes ou d'autres procès de putrescence.

Les »fêlures stelliformes transparentes», dans la région de la vésicule biliaire, n'ont jusqu'ici guère été prises en considération dans le roentgendiagnostic, et la cause de l'apparition de *ce nouveau symptôme roentgenologique* n'avait pas, jusqu'à ce jour, été élucidée. Les fêlures remplies de gaz, dans les calculs biliaires, peuvent, bien que ne constituant que des trouvailles rares, rendre en certains cas possible un diagnostic de calcul biliaire, dans les cas où les concrétions elles-mêmes n'ont pu, roentgenologiquement, être autrement constatées.

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AUS DER RÖNTGENABTEILUNG DER UNIVERSITÄTSKLINIK IN UPPSALA
(CHEF: PROF. H. LAURELL)

EIN FALL VON 360° SIGMOIDEUMVOLVULUS OHNE STRANGULATION UND MIT UNBEDEUTENDEN BESCHWERDEN[1]

von

Bengt S. Holmgren

Man unterscheidet gewöhnlich zwischen physiologischem und pathologischem Volvulus. Der erstere verläuft ohne Symptome, und die Umdrehung um die Mesenterialachse beträgt höchstens 180°; der letztere verursacht im allgemeinen mehr oder minder ausgesprochene Beschwerden, und die Umdrehung beträgt mindestens 180°. Eine scharfe Grenze zwischen diesen Volvulusformen besteht jedoch nicht; was zu einer Zeit mit Recht als ein physiologischer Volvulus bezeichnet werden kann, kann zu anderer Zeit — trotz desselben Umdrehungsgrades — in eine pathologische Form übergehen. Ein physiologischer Volvulus trägt indes oft den Keim zu einer pathologischen Form in sich, welche leicht entsteht, wenn die Umdrehung zunimmt.

Wie GROTH an Material der hiesigen Abteilung nachgewiesen hat, ist jeder Darmvolvulus mit einer Axialtorsion des Darmes verbunden. G. veranschaulicht dies an einem Gummischlauch mit längsverlaufenden parallelen Rändern. Wenn man mit einem solchen Schlauch eine Schlinge herstellt, sieht man leicht, dass die Axialtorsion der beiden Schenkel der Schlinge immer doppelt so gross ist wie die Drehung der Schenkel umeinander. Diese Axialtorsion kann, wenn es sich um den Darm in vivo handelt, entweder auf eine oder mehrere kurze Partien der Volvulusschlinge beschränkt sein oder sich über die ganze Schlinge oder einen grösseren Teil derselben erstrecken, oder es können auch diese beiden Möglichkeiten kombiniert sein. Die Axialtorsion braucht nicht einmal ganz in den beiden Schenkeln einer Volvulusschlinge zu liegen, sondern kann sich oft teilweise in deren Fortsetzung ausserhalb der torquierten Schlinge befinden. Theoretisch wäre es denkbar, dass die Axialtorsion

Bei der Red. am 19. IV. 1938 eingegangen.

ga[illegible] ausserhalb der beiden Schenkel läge, aber in Wirklichkeit dürfte di[illegible] niemals vorkommen. Bei einem Volvulus von 180° oder weniger könne[illegible] Übergangsformen zwischen einer örtlich beschränkten Axialtorsion u[illegible] einer Knickbildung, eine sog. Knicktorsion, entstehen, eine Bezeichnu[illegible], die von LAURELL eingeführt worden ist.

Die Entstehung eines Volvulus an einem langen und frei beweglichen D[illegible]nteil mit freiem Mesenterium ist oft durch die verschiedene Verteilung vo[illegible] Gas bzw. festem und flüssigem Inhalt in den Darmteilen bedingt, we[illegible]he die Möglichkeit haben, sich umeinander zu schlingen. Dies besag[illegible] mit anderen Worten, dass das verschiedene spezifische Gewicht der Vo[illegible]vulusschenkel häufig von entscheidender Bedeutung für ihre Lage zu[illegible]nander ist (LAURELL); bei Drehung des Körpers im Liegen können sich die beiden Schenkel, wenn ihr spezifisches Gewicht wesentlich verschieden ist, umeinander drehen, soweit der Raum in der Bauchhöhle es gestattet.

Die Symptome eines Volvulus sind teils durch den Grad der Obturation des Darmlumens (hauptsächlich durch Axialtorsion und Kompression), teils durch den Grad der Strangulation der Mesenterialgefässe (vor allem der Venen) bedingt. Schon bei einem Volvulus von 180° oder weniger kann eine örtlich beschränkte Axialtorsion das Darmlumen verengen und als einziges Symptom eine erschwerte Passage hervorrufen (GROTH). Kommt auch ein gewisser Grad von Strangulation der Gefässe hinzu, so erhält man eine seröse oder serös-blutige Transsudation in das Darmlumen. Gleichzeitig findet auch reichliche Gasbildung in dem strangulierten Darm statt, und zwar schon bei einer ziemlich mässigen Strangulation. Bei länger anhaltender Strangulation kommt es oft auch zu Austritt einer grösseren oder kleineren Menge Flüssigkeit in die Bauchhöhle sowie zu Blutungen im Mesenterium, vor allem an der Mesenterialwurzel. Allmählich tritt bei starker Strangulation Gangrän des strangulierten Darmteils ein, wenn er nicht rechtzeitig reponiert wird. Besteht eine Verbindung zwischen der Strangulierten Schlinge und ihren zu- oder abführenden Teilen, so kann natürlich sowohl das Gas als die Flüssigkeit in der Volvulusschlinge in benachbarte Teile des Darms in aboraler oder oraler Richtung eindringen. Im ersteren Fall gehen reichlich Gas sowie diarrhöische und diarrhöisch-blutige Massen per rectum ab, im letzteren wird ein Teil des Gases in den oralen, nicht strangulierten Teilen resorbiert. In der Regel dringt das Gas nicht in den Dünndarm ein. Die Menge von Gas bzw. Flüssigkeit ist jedoch gewöhnlich in dem strangulierten Teil am grössten. Im Gedanken an Sigmoideumvolvulus sei indes hier betont, dass beim Abgang von Gasen in aboraler Richtung die Erweiterung der strangulierten Sigmoideumschlinge minimal sein kann (siehe unten).

Wenn man bei Durchleuchtung gesehen hat, mit welcher Leichtigkeit frei bewegliche Darmteile, falls sie verschiedenes spezifisches Gewicht

haben, bei Veränderung der Körperlage im Verhältnis zueinander verschoben werden, begreift man, dass eine freie, lange Darmschlinge oft Volvuluslage einnimmt und sich wieder reponiert, wenn der Raum es gestattet.

Wenn nun ein pathologischer Volvulus von mehr als 180° entstanden ist und sich in ihm reichlich Gas und Flüssigkeit gebildet hat, kann es sehr leicht geschehen, dass bei geringem Raum in der Bauchhöhle dieser Volvulus dadurch fixiert wird, dass die weiten Volvulusschenkel nicht aneinander vorbeipassieren können. Durch die fortgesetzte Erweiterung der Volvulusschlinge entsteht teils eine vermehrte Straffung des Darmmesenteriums, teils eine Verschiebung der Umdrehungsstelle gegen die Schlingenbasis, teils endlich eine straffere Anziehung des Mesenteriums und seiner Gefässe durch die verschlungenen Darmschlingen und damit ein gesteigerter Meteorismus; auf diese Weise kommt es also zu einem Circulus vitiosus, wenn die Umdrehung nicht spontan oder künstlich (Lavement) gelöst wird.

Klinisch unterscheidet man zwischen chronischem, subakutem und akutem sowie intermittentem Volvulus. Der chronische verläuft gewöhnlich mit unbestimmten Symptomen in Form von Verstopfung, bisweilen gesteigerter Flatulenz, bisweilen Schmerzen im Bauch, diffusen oder in der linken Fossa iliaca lokalisierten. Die akute Form bietet oft das Bild eines akuten Ileuszustandes. Zwischen diesen beiden steht der subakute Volvulus, der nicht allzu selten in Attacken in Form von Schmerzanfällen ohne Abgang von Gas oder Stuhl verläuft. Bei relativ freier Passage aboral von der Volvulusschlinge kann bisweilen reichlicher Abgang von übelriechendem Gas und lockerem Stuhl mit oder ohne Blutbeimischung stattfinden. Manchmal treten reflektorische Erbrechen auf. Das Bild kann mit anderen Worten stark variieren und wird oft unrichtig gedeutet. Eine scharfe Grenze zwischen den verschiedenen Formen findet sich nicht. Sie können ineinander übergehen oder abwechselnd auftreten. Unter intermittentem Volvulus versteht man natürlich einen Volvulus, der mit freien Intervallen auftritt. Es handelt sich dabei im allgemeinen um mehr akute oder subakute Formen. Die Volvulusdiagnose lässt sich in den meisten Fällen schwer ohne Röntgen stellen. Durch Übersichts- und Niveauaufnahmen sowie Kontrasteinläufe erhält man oft sehr typische Bilder, welche die Röntgendiagnose, wenn es sich um den Dickdarm handelt, ziemlich leicht machen. (Das oben Gesagte gilt natürlich hauptsächlich für das Colon.)

Aus der hiesigen Abteilung hat LAURELL (1937) 31 röntgendiagnostizierte Volvulusfälle aus der Zeit 1923—1936 veröffentlicht. Von diesen waren 25 Sigmoideumvolvulus, 3 Transversumvolvulus, 1 Coecumvolvulus und 2 Dünndarmvolvulus. Unter den 25 Fällen von Sigmoideumvolvulus befanden sich 8 akute, 4 subakute und 13 chronische. Die gewöhnliche

Volvulusform ist ohne Zweifel Sigmoideumvolvulus. Hier handelt es sich nämlich um einen Darmteil, der oft ziemlich lang und mit freiem Mesenterium versehen ist. Bei habitueller Obstipation kann dieser Darmteil bedeutend an Länge zunehmen, wodurch die Bedingungen für einen Volvulus grösser werden. Die früher als eine besondere Krankheit betrachtete Mesosigmoiditis kann denkbarerweise auf früheren Volvulusattacken beruhen, welche wiederholte Blutungen im Mesosigmoideum mit sekundärer schwieliger Schrumpfung herbeigeführt haben (LAURELL). Diese Umdrehungen sind spontan oder durch Lavement reponiert worden, und die Symptome, die man als Ausdruck der sog. Mesosigmoiditis beschrieben hat, können nach dieser Deutung als Ausdruck mehr oder minder schwerer Volvulusattacken aufgefasst werden. Durch den Schrumpfungsprozess im Mesosigmoideum nähern sich die Fusspunkte der beiden Schenkel der Volvulusschlinge einander immer mehr, und hierdurch vergrössern sich ihrerseits die Bedingungen für die Entstehung eines fixierten Volvulus, was die bekannte Tatsache erklären kann, dass das klassische Bild von akutem Volvulus in hohem Alter häufiger ist. Da ein langes Sigmoideum so äusserst gewöhnlich ist, dürfte man wohl sagen können, dass leichte chronische und subakute Formen von Sigmoideumvolvulus bedeutend häufiger sind, als man bisher geglaubt hat. Sie kommen indes selten zur Diagnose, sondern werden als Obstipation, Leibschneiden u. dgl. bezeichnet. Ein bei diesen Formen ziemlich gewöhnliches, aber wenig beachtetes oder falsch gedeutetes Symptom ist der Abgang von übelriechendem Gas und diarrhöischen oder diarrhöisch-blutigen Massen per rectum. Dies gilt vor allem für die keineswegs seltenen Fälle, wo die Strangulation augenfällig, aber die Obturation in aboraler Richtung unvollständig ist. Bei ihnen liegt kein aufgetriebener meteoristischer Bauch mit tastbarer, erweiterter Sigmoideumschlinge vor, da der Darminhalt per rectum abgeht. Das Lumen des Sigmoideum kann dann im grossen und ganzen normale Weite haben, aber seine Wand ist stark hyperämisch und ödematös. Infolge der geringen Erweiterung der Sigmoideumschlinge werden diese Fälle meist ziemlich leicht entweder spontan oder durch Lavement reponiert und kommen deshalb selten zur Röntgenuntersuchung, obgleich diese das einzige Mittel ist, eine sichere Diagnose zu stellen. Wegen des wechselnden klinischen und röntgenologischen Bildes wird auf LAURELLS Arbeit von 1937 verwiesen.

Auf der hiesigen Röntgenabteilung sind ausser den von LAURELL beschriebenen Fällen kürzlich noch ein paar weitere Fälle von Sigmoideumvolvulus diagnostiziert worden, von denen besonders einer wegen des ungewöhnlichen klinischen und röntgenologischen Bildes Beachtung verdient.

Med. Journ. Nr. 89/38. T. P., Mann, 68 Jahre. Früher immer gesund. Seit Juni 1937 diffuse Spannungen oben im Bauch. Im November 1937 traten Erbrechen auf. Diese

waren nicht von Retentionstypus und stellten sich gewöhnlich mehrere Stunden nach den Mahlzeiten ein. Im letzten Halbjahr hatte Pat. den Appetit verloren und ca. 10 kg abgenommen. Die Beschwerden waren im letzten Monat vor der Aufnahme in die hiesige Medizinische Abteilung leichter gewesen, und Pat. hatte damals nur ein paarmal erbrochen.

Träger Stuhl in den letzten 2—3 Jahren, oft Intervalle von 2—3 Tagen. Vor der Aufnahme hatte Pat. 8 Tage keinen Stuhl gehabt, aber trotzdem nicht an Erbrechen gelitten. Er hatte niemals rotes Blut oder Schleim im Stuhl bemerkt, einmal während der Krankheit war ihm jedoch aufgefallen, dass der Stuhl teerfarben war. Niemals lockere Stühle. Keine Defakationsbedürfnisse, die nicht befriedigt werden konnten.

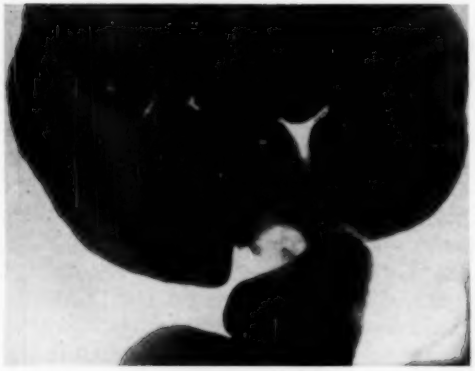


Fig. 1.

Pat. wurde am 30. 12. 1937 unter Verdacht auf Cancer ventriculi in die hiesige Medizinische Abteilung aufgenommen. Status am 30. 12. 1937. Bauch: weich und vollständig unempfindlich, Bauchdecken dünn; links vom Nabel sowie in der linken Fossa iliaca wurden in der Tiefe ein paar pflaumengrosse, feste, verschiebbare Tumoren getastet, die als Skybalaklumpen aufgefasst wurden; im übrigen keine pathologischen Resistenzen; keine erweiterten Därme sichtbar oder palpabel.

Röntgenuntersuchung von Ventrikel und Duodenum am 31. 12. 1937 zeigte einen normalen Ventrikel, aber eine ca. erbsengrosse Ulcusnische im Bulbus duodeni. Geringer Rest nach 5 Stunden.

Am 1. 1. 1938 war Weber —, aber am 2. 1. ++ (Fäzes damals teerschwarz). Das nächste Mal, als man eine Stuhlprobe nahm, am 5. 1., war Weber wieder negativ und blieb negativ, solange sich Pat. im Krankenhaus befand. Während dieser Zeit hatte er nur zweimal spontanen Stuhl. Er erhielt täglich oder jeden zweiten Tag Lavement, in den meisten Fällen mit gutem Resultat.

Am 4. 1. 1938 wurde *Röntgenuntersuchung mit Kontrasteinlauf in das Colon* vorgenommen (um zu untersuchen, ob Colonkanzer vorlag): Der Kontrast drang ohne Schwierigkeit in das Rektum und in das Sigmoideum hinauf. Ungefähr am Übergang zwischen Rektum und Sigmoideum etwas links im Becken war indes das Darmlumen innerhalb eines ca. 3—4 cm langen Gebietes nur fingerweit. Das Sigmoideum füllte sich ohne Schwierigkeit, aber am Übergang zum Colon descendens stiess der Kontrast auf ein absolutes Hindernis, das anfangs nicht zu überwinden war. Es zeigte sich nun, dass die Sigmoideumschlinge in einem Volvulus von 360° lag (siehe Fig. 1). Durch Druck auf den Bauch und Palpieren desselben gelang es, eine geringe Kontrastmenge in das Colon descendens hinaufzubringen und nun boten sich äusserst lehrreiche Bilder, welche teils zeigten, wie sich die beiden Schenkel umeinander schlangen, teils stark spiralförmig ge-

Fig. 2.

Fig. 3.

wundene Schleimhautfalten an der Umdrehungsstelle erkennen lies en, entstanden durch die vor allem in dieser Gegend gelegene Axialtor ion (Fig. 2, Tafel I). Die Spiraldrehung der Schleimhautfalten tritt am be ten am Übergang zwischen Rektum und Sigmoideum hervor (Fig. 3, Tafe I). Die gesamte Axialtorsion des Darmes, die in diesem Falle 720° betra gen haben muss, war offenbar grossenteils auf die übrige Sigmoideumschl nge verteilt und lag möglicherweise auch etwas ausserhalb der Volvulusbildung. (Es ist unmöglich, mit Röntgen zu entscheiden, ob die Axialtorsion des Darms alle dessen Schichten gleichmässig betrifft). Als man dann Pat. aus der früheren Rückenlage in Bauchlage drehte, reponierte sich dieser Volvulus auf etwa 270°, und der Kontrast stieg nun ziemlich unbehindert in das Colon descendens.

Fig. 4.

Bei Kontrolluntersuchung des Colon am 24. 1. 1938 mit Kontrastlavement wurde festgestellt, dass das Sigmoideum nun in einem Volvulus von 180° lag, der durch Drehung des Patienten und Manipulationen an seinem Bauch mit einer gestielten gedrechselten Holzkugel leicht zu reponieren war (Fig. 4). Im übrigen keine Veränderungen im Colon sichtbar, abgesehen von ziemlich reichlichen Skybala. Kein abnormer Meteorismus. Nachdem Pat. den Kontrast von sich gegeben hatte, war das ganze Sigmoideum entleert; es zeigte nun nur einen dünnen Kontrastbelag und lag gut zusammengefallen und kontrahiert im Becken.

Am 5. 2. 1938 wurde Pat. symptomfrei entlassen, nachdem er eine Ulkuskur durchgemacht hatte.

Das Ulcus duodeni des Patienten scheint die meisten seiner Symptome erklären zu können. Der Sigmoideumvolvulus von 360°, den man bei der ersten Colonuntersuchung fand, dürfte keine subjektiven Beschwerden verursacht haben, denn die Umdrehung war locker, nicht gestraft, und die gewöhnlichen Strangulationszeichen, wie Meteorismus, Bauchtranssudat, blutige oder diarrhöische Stühle, abnormer Gasabgang und geschwollene Schleimhaut, fehlten. Möglicherweise war die Obstipation teilweise durch das relativ lange Sigmoideum und die Volvuluslage bedingt, die bei den Untersuchungen zwischen 360° und 180° wechselte. I

Fall zeigt also einen Sigmoideumvolvulus von 360° ohne sichere Strangulationszeichen, der unblutig reponiert werden konnte. Es dürfte indes nicht allzu unwahrscheinlich sein, dass, wenn sich später einmal wieder ein solcher Sigmoideumvolvulus bildet, die Umdrehung sich stärker strafft, so dass eine Strangulation entsteht, die eventuell über eine Mesosigmoiditis nach einer unbestimmten Anzahl von Jahren zu mehr oder minder ernsten Volvuluszuständen führt. Durch eine stuhlfördernde Diät muss man bei allen diesen latenten Volvuluszuständen jede Stockung im Sigmoideum zu verhindern suchen, die seine Länge und überhaupt die Neigung zu Volvulus vergrössert.

ZUSAMMENFASSUNG

Verf. erörtert in Kürze Darmvolvulus (vor allem im Sigmoideum) und weist darauf hin, dass die chronischen und subakuten Volvuluszustände bedeutend häufiger, als man sich vorstellt, und oft Vorläufer der akuten sind. Die erstgenannten Formen können mit Sicherheit nur mittelst Röntgen diagnostiziert werden, aber da die Beschwerden bei ihnen oft ziemlich leicht und meist vorübergehend sind, kommen die Kranken selten zur Röntgenuntersuchung.

Verf. beschreibt weiter einen interessanten Fall von 360° Sigmoideumvolvulus ohne Zeichen von Strangulation, unter anderem ohne meteoristische Erweiterung. Derselbe verlief ohne eigentliche Symptome und liess sich durch Kontrasteinlauf in das Colon unter Röntgendurchleuchtung leicht reponieren.

SUMMARY

The author gives a brief review of volvulus of the intestine (especially of the sigmoid portion) and points out that chronic and subacute volvulus are considerably more common than is believed and are often precursors of the acute condition. The diagnosis of the former is only certain with the help of roentgen examination but as the complaints are often temporary and rather mild the patients seldom are subjected to this examination.

The author describes an interesting case with 360° volvulus of the sigmoid and no evidence of strangulation nor even meteorism. There were no actual symptoms and reduction was accomplished on the injection of contrast medium into the colon during fluoroscopy.

RÉSUMÉ

L'auteur rend brièvement compte du volvulus de l'intestin (en particulier, du sigmoïde) et fait ressortir que le volvulus chronique et subaigu sont beaucoup plus communs que l'on ne l'imagine et qu'ils sont souvent précurseurs des états aigus. Le diagnostic des formes citées en premier ne peut être posé avec certitude qu'à l'aide de l'examen roentgen, cependant, comme les symptômes de ces mêmes cas sont souvent légers et le plus souvent passagers, les malades ne viennent que rarement à cet examen.

L'auteur décrit en outre un intéressant cas de volvulus du sigmoïde à 360° sans signes de strangulation ni, entre autres, de dilatation météorique. Il n'y eut pas de symptômes propres, et la réduction se fit par infusion de contraste dans le côlon, avec radioscopie.

LITERATUR

GROTH, Acta Rad., Bd. 15, 1934.
LAURELL, Acta Rad., Bd. 7, 1926.
—, Tarmvolvulus från aetiologisk, pathogenetisk och diagnostisk synpunkt, Uppsala Universitets årsskrift 1937: 3. — Die Arbeit umfasst 107 Seiten, davon 4 Seiten Zusammenfassung in deutscher Sprache.

Im übrigen wird auf die ausführlichen Literaturverzeichnisse in diesen drei Arbeiten verwiesen.

FROM THE CLINIC OF THE »ANTONI VAN LEEUWENHOEKHUIS» AMSTERDAM.
DIRECTOR: DR W. F. WASSINK

OME RESULTS OF IRRADIATION WITH SOFT RÖNTGENRAYS AT A VERY SMALL FOCUS-SKIN-DISTANCE (CONTACT-THERAPY)[1]

by

Dr *D. den Hoed*

Some years ago VAN DER PLAATS made a publication about what he called »Röntgencaustic», a method of irradiation principally corresponding with the so called »Nahebestrahlung» by CHAOUL, which has been much discussed in the literature on radiotherapy.

In the latter the starting-point was the experience that for many kinds of localisations of tumours, radium therapy is to be preferred to Röntgen treatment. According to the most likely opinion this preference is not based on a particular more or less specific action of radium-rays (γ-rays), but on technical conditions. The chief difference is the fact that in most cases radium is placed at a short distance from or into the affected object to be radiated, so that a high dose can be locally applied into the lesion without the surrounding tissues, considered healthy, absorbing a considerable quantity of radiation energy. So it is possible to apply in the before mentioned treatment a kind of local super-dosage, which does severely injure the pathological tissues, but does not do much harm to the surroundings, so that reactions may arise which remove the rest of the malignant cells after which the regenerating powers of the neighbouring tissues may bring about a complete recovery.

In order to irradiate with Röntgen-rays in such a way that the decrease of intensity in the depth is as strong as in contact-radium-treatment we can proceed in two manners:

1st. We may choose soft Röntgen-rays, in other words rays generated at a low tension with only slight filtering.

2nd. We may take a small skin-focus-distance, in which case according to the law of the squares the intensity decreases very quickly in the depth.

On the ground of these considerations the laboratory of the Philips works at Eindhoven has designed a tube in which the principles discussed

[1] Submitted for publication March 21, 1938.

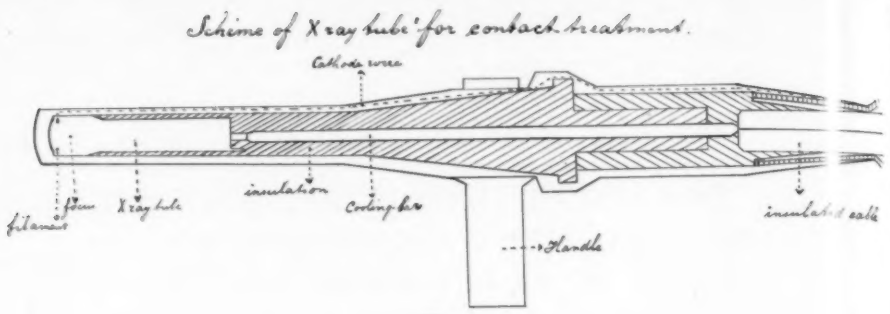


Fig. 1.

are applied. For this purpose »shock-proof» tubes have been chosen, so constructed that parts under high tension are nowhere to be touched. Besides it is necessary that the dimensions should be such that very small skin-focus-distances can be used. The solution chosen by BOUWERS c. s. has been derived from one of the principles formerly used for the construction of some Röntgen-diagnostic-tubes, the focus of which was fairly close to the end of the tube, while the filament had been led round about it. The scheme of the tube is illustrated in the annexed sketch (fig. 1).

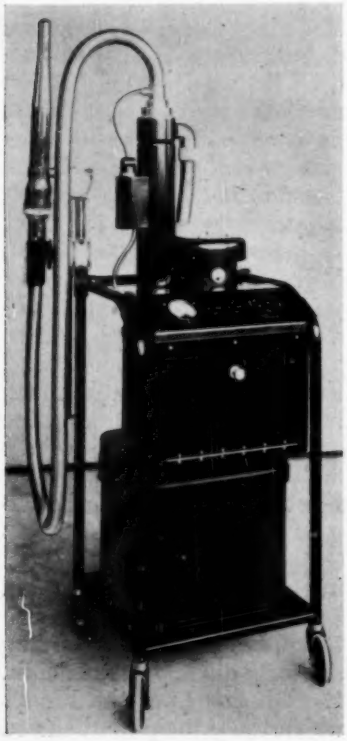


Fig. 2.

The whole fitting-up of the apparatus, which the firm of Philips kindly gave us for further experiments, is represented in the annexed illustration (fig. 2).

The tube is run at 3 m A. with a tension of 50 kV. The minimum focus-skin-distance is 2 cm. The filter is the glass wall of the tube, and a small bakelite cover.

By means of differently made applicators it is possible to exactly focus smaller fields and larger distances. The maximum field in case of contact radiation is somewhat smaller than 3 cm. The conical width of the bundle of rays is about 75°. When treating irregularly

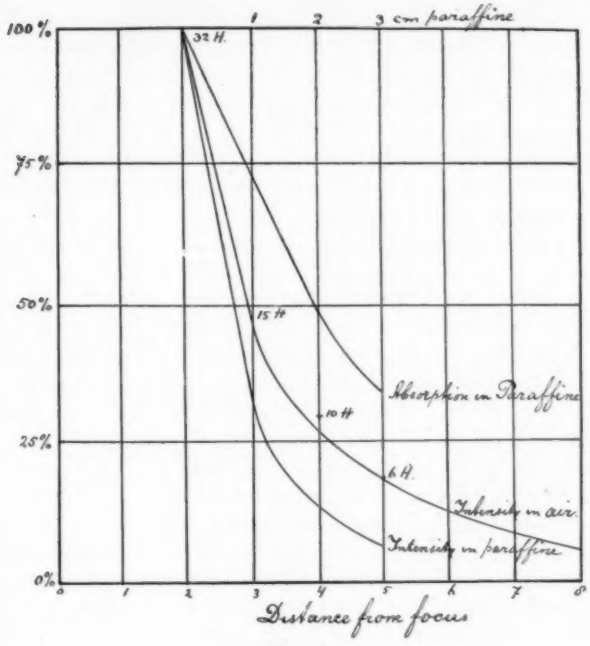


Fig. 3.

formed affections one can cover up the surrounding parts with leaf-lead.

The dosimetry entails some difficulties, because owing to the very short distance at which this tube can be used, the iontometrical method cannot supply all values desired. With a small ionisation chamber it is rather difficult to measure much closer than at 1 cm. from the bakelite cover, while the tube is often used as a contact apparatus.

It is doubtful if at this very short distance the law of squares holds good; therefore I combined for measurements the photochemical method with the iontometrical mode, constructing with the aid of an ionisation chamber an intensity curve for the greater distances of 3 up to 8 cm. from the focus and by means of »Holzknecht-pastilles» a curve of 2 up to 5 cm. These curves partly cover each other and thus they are complementary to one another. In this manner the intensity-distribution according to distance is to be determined fairly exactly up to 2 cm. (the shortest distance possible). From these measurements it became apparent that the law of squares holds good even at these short distances, also thanks to the extremely small focus these tubes possess.

In order to ascertain the depth dose we have constructed an absorption curve in paraffine, and the combination of the two curves now indicates the real depth dose in paraffine in case of contact radiation in human tissue we get about the same results (fig. 3).

In figure 3 the uppermost curve reproduces the absorption in paraffine, of the determination of which was made by putting layers of paraffin of different thickness between the ionisation chamber and the tube. At the same time a large lump of paraffine had been laid under the ionisation chamber, by which arose the same backscattering as in ordinary circumstances. The starting point of this curve (100 per cent.) has been arbitrarily chosen at the beginning of the curve of intensity in air. In this way the calculation of the real course of intensity in paraffine (undermost curve), in which the increase of distance as well as the absorption are taken into account, becomes surveyable.

The middle curve was obtained by the combination of photochemical and iontometrical intensity-measurements discussed before.

The numbers 32 H, 15 H, 10 H and 6 H represent as many Holzknecht-units per $^3/_4$ of a minute, the remainder of the curve was iontometrically determined. The undermost solid curve has been formed by the combination of the two others. In order to give an explanation of the way in which this curve is determined we shall calculate some points of it. At a distance of 1 cm. from the bakelite cover (point A of the curve), that is at 3 cm. from the focus-proper, there would still be 46 per cent of the surface intensity, if the distance only caused the decrease in intensity. However, the absorption and scattering by the paraffine must be taken into account, which gives a loss of about 27 per cent, so at a depth of 1 cm. there remains: $\frac{73}{100}$ of $\frac{46}{100}$, that is about 33 per cent of the surface intensity. At 2 cm. from the bakelite cover (point B), thus at 4 cm. from the focus, according to the law of squares, the loss is about 73 per cent. (so the rest in 27 per cent.) and owing to the absorption and scattering 50 per cent. (rest 50 per cent.). Thus together there remains 50 per cent. of 27 per cent. that is about 13 per cent.

For purposes of comparison we show the following curves, obtained from ordinary radium applicators, which are also used in skin-therapy and in which the size of the field is about the same as in the case of contact radiation by means of the »caustic» apparatus. The great decrease of intensity now occurring is of the same order of magnitude as one observes when the »caustic» apparatus is used (fig. 4).

Thus in all these modes of radiation we obtain a very slight depth action, so that even in case of local high overdosage no deep necrosis is brought about.

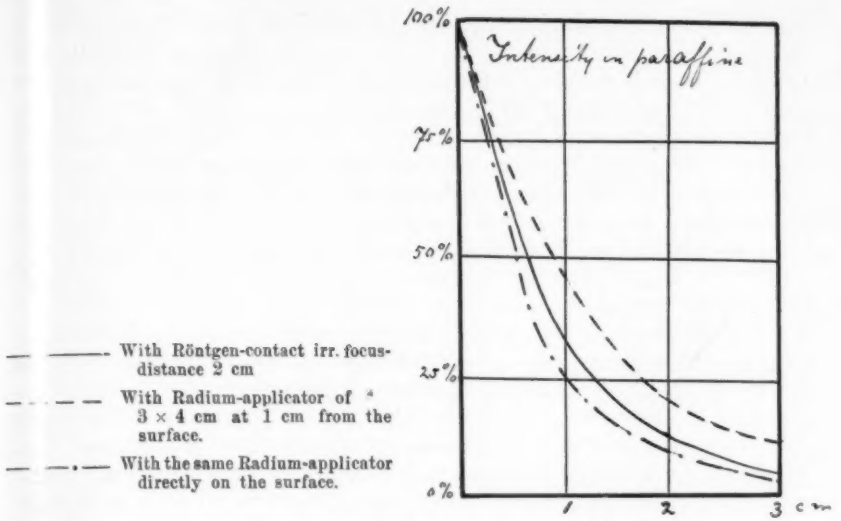

100%
75%
50%
25%
0%
1
2
3 cm
— ——— With Röntgen-contact irr. focus-distance 2 cm
— - — - With Radium-applicator of 3 × 4 cm at 1 cm from the surface.
— —·— With the same Radium-applicator directly on the surface.

Fig. 4.

As for the biological effect of these soft Röntgen-rays we refer to experiments we performed some years ago, in which rays of about the same quality were made use of with the following effects. With the same dose the rays proved to have the same action as harder rays have on the objects experimented with.

Table I

Mortality of Drosophila eggs

K. V.	Filter in m. m.	Mortality
60	0	59.5 per cent
100	1 Al	59.5 » »
150	0.3 Cu	60.5 » »
180	1 Cu	60.5 » »

The course of erythema in the same patient has been examined after application of 600 r. of different quality. The 60 kV. radiation which is nearly equal in quality to the radiation of the Philips contact therapy tube corresponds in effect with all other radiations applied, so that the course of redness of the skin for all kinds of rays was indicated by the same curve.

At histological checkings, repeatedly made, tumour tissues proved to show the well-known injuries after radiation with this Philips contact tube.

Let us now ascertain its practical application.

We have deviated from the method used by CHAOUL and VAN DER PLAATS, because the strongly fractional treatment has a drawback: we are obliged to make the patient come back repeatedly. It is true he has to be treated only a few minutes a day, yet the total loss of time, both for patient and radiologist becomes very considerable, while such a treatment entails many difficulties for country-people, who sometimes have some hours to travel. For this reason we preferred to avoid highly fractional treatment and resolved to apply the whole dose within one or two days, depending on the extension of the affections. Using this method we have treated more than 150 patients with skin cancer, 12 with lip lesions, 18 with cutaneous metastases from other cancers, 11 with hyperkeratosis of the skin (praecarcinoma), 6 patients with cancer of the mucous membrane of the mouth or pharynx, 4 with cancer of the rectum, 5 sarcomata (one sarcoma of the maxilla, 1 of the palatum, 1 of the cavum nasi, 1 from subcutaneous tissue and 1 melano-sarcoma from the conjunctiva bulbi).

Moreover I radiated some benign affections (angioma, pruritis, eczema, keloid, epulis, lupus, verruca vulgaris, neavus, tuberculide), together more than 200 patients. For a number of patients the treatment took place only a short time ago, so that we cannot yet discuss the results, but will only give information about those of whom the time of observation (more than half a year) is long enough to judge of the primary results of the radiation. Though one might remark that a period of observation of half a year is too short in carcinoma, we are of opinion after our experience with more than one thousand cases of cutaneous cancer, that we know the reaction and the course of this kind of tumour sufficiently to make a prognosis.

All patients with hyperkeratosis recovered. Out of 113 patients with in total 147 skin tumours 106 patients were cured. 136 tumours recovered immediately, besides this 4 tumours were healed after having been treated for a recurrence, 2 patients with very extensive lesions died, 1 patient with a very extensive lesion is in good health but not quite cured and 2 patients were lost sight of.

The reaction following the seemingly heavy treatment manifests itself in an erythema, developing after about a week, whilst in the meantime the tumour already begins to shrink. This erythema increases if a higher dosage is used; later on there arises an epidermolysis with a fibrinoid coating. This reaction mostly disappears in 4 to 8 weeks. After this the state of the skin is practically normal; a slight shifting of the pigment to the periphery and a hardly observable atrophy of the dermal tissue are the only signs of the preceding irradiation. Only where there was already a considerable defect of the skin before the radiation, scar tissue, poor in vessels, developed. Some of the patients treated with very

high fractional doses recovered after a long reaction with a fibrinous coating of the ulcer.

Successes were attained in all histological types in equal measure (basalcell carcinoma, epidermoid carcinoma of the skin- and the mucous-membrane-types and carcinoma solidum). Most of the carcinomata treated were small, the largest 4 to 8 cm. The dose varied from 1,700 r to 7,000 r per field, depending upon the estimated thickness of the tumours. Mostly we use a dose of 3,000 r. In very extensive carcinoma we now give about 5,000 r per field. In superficial tumours 1,700 r may be deemed to be sufficient, which dose is reached within 40 seconds.

Among the other tumours only the group of the labial affections was in a measure important. Out of the 12 patients in this group treated with Röntgen contact therapy 11 were irradiated more than six months ago. In 7 of them carcinoma was microscopically found out; in 4 cases the diagnosis stated praecarcinoma, 3 of which hyperkeratosis and 1 papilloma. The 7 real carcinomata were only superficial affections, for the more infiltrating tumours we have up till now preferred radium treatment.

In patients with rectum carcinoma — all of them most serious cases — treated per vias naturales we did not obtain any satisfactory results.

Cutaneous metastases — for the most part from mammary carcinoma — reacted markedly well, and especially for this prognostically very unfavourable affection our method of treatment proved to be an acquisition. We applied about 2,000 r to each metastasis and its immediate surroundings.

Out of 6 patients with cancer of the mucous membrane of the mouth 2 were cured; 1 of the latter with a recurrence of palatal cancer refused radium treatment, the other was a woman, aged 80, who because of the dangers involved in a long and heavy radiation was treated with Roentgen contact exposure after the excision of the fairly small growth of the tongue.

Of the 5 patients suffering from sarcoma 3, with very extensive recurrences, were only for some time favourable influenced to a certain extent, 1 was cured of a subcutaneous sarcoma by excision and Roentgen-contact after-treatment, while the 5th with melanosarcoma of the conjunctiva bulbi recovered with the exception of a small remnant, which was electro-coagulated.

The benignant affections were as a rule favourably influenced.

Angiomata in children mostly improved or were cured with a dose of 600 to 800 r, if need be once or more repeated.

A few cases of chronic eczema were also cured by using small dosages, namely two or three times 200 r.

Some cases of epulis recovered after one of more exposures to some 1,500 r.

The keloids, too, though not entirely removed, were much improved.

Of the patients with tubercular affections the cases of lupus although temporarily improved, showed no lasting result, whereas one patient suffering from tuberculide of the skin was successfully cured with three times 200 r.

Verrucae vulgaris, treated in rather large numbers, mostly disappeared after local application of some 1,500 to 2,000 r.

Table II

Nature of the disease	Number of patients	Number of tumours	Number of primary cured tumours	Number cured after recurr.	Percentage of cures
Cancer of the skin	113	147	136	4	92
			140		95
Hyperkeratosis of the skin . .	11	11	11		100
Cutaneous metastases	18	many	all patients temporarily improved		
Cancer and precancer of the lip	11	11	11		100
Oral cancer	6	6	2		
Rectum cancer	4	4	0		
Sarcomata	5	5	1	1	
Angiomata	15	18	2 + 9 much improved + 5 cured by combined treatment		
Miscellaneous	21	see extensive summary page 7 and 8			
Total	204				

Case 1. H. M. 6435. A typical case for Röntgen-contact-irradiation; a man 74 years of age, not wishing to be hospitalised, with an extensive carcinoma of the skin of the nose. Patient was radiated with 2 fields on December 30th 1935, and on 2nd and 7th January, 1936. Together on the left side about 1,700 r, on the right side 1,200 r. After reaction with epidermolysis and fibrinoid coating patient was cured on the 24th of March, which recovery has continued to the present (see fig. I).

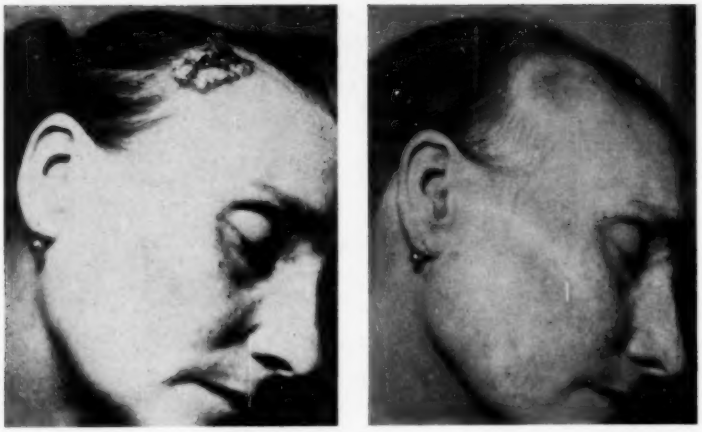
Case 2. H. M. 6412. A patient, 64 years old, suffering from tabo-paralysis, having several cancers of the skin of the face, most of which were treated with radium. The tumour of the nose, having permeated throughout the cartilage and brought about defects of the tissue, recurred, and was therefore treated with contact-radiation, in which 4 fields were applied. Together about 11,000 r divided over 4 days. Patient recovered although with defect of the tissue. (See fig. II.)

Case 3. H. M. 8983. A woman, 53 years old, with extensive basalioma of the forehead. In the course of 10 days a dose of some 4,000 r was applied. After a few months there was only a small part of the tumour left, which was cured after application of some 2,500 r (see fig. V).

Case I.

Case II.

Resuming our observations we conclude that the Philips apparatus for contact-radiation is of much use in swift treatment of not deeply penetrating cancer of the skin, and in this case can replace radium, having the advantages of easier application, less dangers for the physician, directed bundle, greater and homogeneous intensity. The great advantage this radiation has in common with radium treatment is a strong local



Case III.

effect, thanks to which the deeper tissues remain undamaged, even if extremely heavy doses are used.

With our extremely-high-intensity method we succeed within 1 to 4 minutes in destroying practically all cancers of the skin which are not too extensive. From a cosmetical point of view we would stress the unsurpassable »restitutio ad integrum».

How much value contact-therapy has for the internal organs within reach from the outside (vagina, uterus, rectum, mouth, mesopharynx) we cannot state and we must follow a »wait and see» policy. The material collected does not justify us to make a conclusion in this respect.

In a disease so dangerous as cancer we can only modify the existing methods of treatment step by step, so that the careful therapeutist has an opportunity of experimenting with this method only in comparatively few cases.

SUMMARY

The principles of contact irradiation with soft Röntgen rays are discussed, with a description of a special Philips tube designed for this purpose. The results of experiments prove that these rays have a similar action on various biological objects as harder rays. The distribution of intensity under special experimental conditions is measured, and in this way the depth distribution is found to be almost identical with that produced by radium-contact-irradiation.

The results of this treatment in relatively superficial skin cancers are very satisfying. Skin metastases of other neoplasmata are also acted upon favourably. A warning is

give , however, against precipitate extension of the applications of this method, which, by i lack of penetrating action, remains a treatment for superficial affections.

ZUSAMMENFASSUNG

s werden die Prinzipien der Oberflächenbestrahlung mit weichen Röntgenstrahlen besp chen und die hierfür entworfene Philips-Röhre beschrieben. Mit Resultaten von Vers chen wurde nachgewiesen, dass die hierbei angewandten Strahlen auf verschiedene biolo sche Objekte dieselbe Wirkung haben wie härtere Strahlen. Es wird die Intensitätsvert ung der Strahlen bei bestimmten Versuchsbedingungen festgestellt, wobei sich zeigt, dass diese Intensitätsverteilung in der Tiefe nahezu derjenigen bei Radiumkontaktbestr hlung entspricht. Die Ergebnisse der Behandlung waren bei relativ oberflächlichen Hau rebsen sehr günstig und ebenfalls wurde auf die Hautmetastasen anderer Geschw lste ein günstiger Einfluss ausgeübt. Gleichzeitig wird aber vor zu schneller Ausc hnung der Indikationen für diese Behandlungsweise, die infolge ihrer geringen Tiefe wirkung doch eigentlich eine Oberflächenbehandlung ist, gewarnt.

RÉSUMÉ

Les principes d'une irradiation superficielle au moyen de rayons Roentgen peu pénétrants sont discutés et le tube Philips construit pour cette irradiation est décrit. Les résultats des expériences prouvent que ces rayons ont une action semblable à celle de rayons plus durs sur différents sujets biologiques. Dans des conditions spéciales d'expérience la distribution est déterminée et il en ressort que cette distribution d'intensité en profondeur concorde presque entièrement avec celle que l'on obtient dans la curiethérapie superficielle.

Les résultats du traitement dans des cas de carcinomes cutanés relativement superficiels ont été très satisfaisants, et on a constaté que les métastases cutanées d'autres tumeurs en sont favorablement influencées.

Il est cependant nécessaire d'avertir contre le danger de l'extension des indications de cette méthode de traitement qui, étant donné son action peu profonde, reste un traitement de surface.

FROM THE ROENTGEN DEPARTMENT, MARIA HOSPITAL, STOCKHOLM.
CHIEF: ÅKE ÅKERLUND, M. D.

AN UNUSUAL OSSIFICATION CENTRE IN THE PELVIS[1]

by

Gösta Lindberg

At the beginning of November 1937 a 15-year old girl, Sonja J. (journal no. 1252/1937) was admitted to the medical department at Maria Hospital for right-sided ischias. From the anamnesis it appears that the patient is the third of a family of five healthy children. Since the spring of 1937 she had occasionally had pains in the gluteal region, principally on the right side in sulcus gluteus. She had had the greatest discomfort in connection with certain movements at gymnastics, such as the forward-downward bend and similar movements. She rides a bicycle without inconvenience, and for the rest can take part in sports to the same extent as her schoolfellows. General status exhibits nothing noteworthy, and the local status shows some tenderness above nervus ischiadicus bilaterally, Lasègue neg. bilaterally, no restriction of movement in the hip-joints, no palpatory tenderness above lumbar vertebrae or pelvis. Suspension stability was 5 mm/1 hr.

At the roentgen examination, made on 5th November 1937, the lumbar lordosis showed a clear straightening out, and there was a slight subluxation forwards of os coccygis. Further, on the left side of the place for spina iliaca ant. inf. there was a 3 cm. long and 2—4 mm. wide well-defined bone shadow, separated from the hip-bone by a narrow interspace (picture 1). On the right side there was no similar bone shadow (picture 2). The patient did not notice any tenderness on control palpation above the free bone shadow, which showed an unchanged roentgen picture at a post examination $2^1/_2$ months later (picture 3).

From anatomical quarters (WALDEYER, TESTUT, etc.) an independent ossification centre in the spina iliaca ant. inf. region has been described.

[1] Submitted for publication April 29, 1938.

Fig. 1. Left hip, 5 Nov. 1937. Ossification centre in spina iliaca ant. inf.

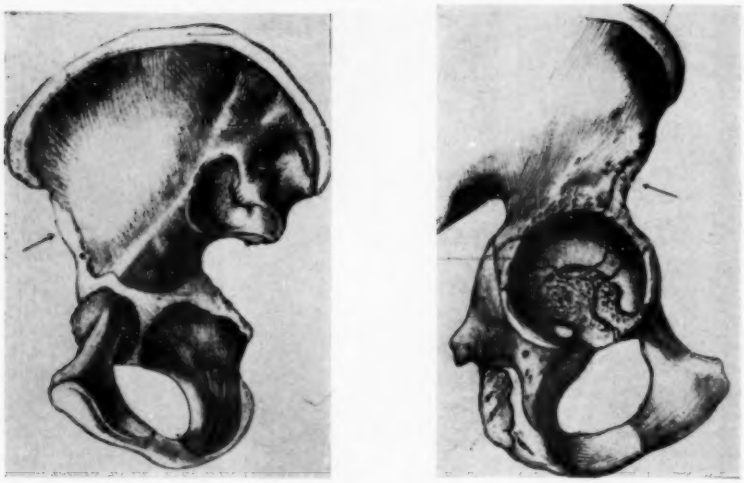
Fig. 2. Right hip, 5 Nov. 1937. The other hip on the same patient.

Fig. 3. Left hip, 15 Jan. 1938. The same hip $2^1/_2$ months later.

It is said to appear at the age of 14—16 and to fuse with os ilium at 16—17 years of age. LANGER-TOLDT considers that the ossification of spina il. ant. inf. takes place from the anatomical os acetabuli, which is said to grow out over the anterior upper margin of acetabulum along the anterior lower part of os ilium (picture 4 and 5). Thus no independent ossification centre in the spina iliaca ant. inf. region was to be found.

Among roentgenological authors, BRAILSFORD and CAMP-CRILLEY have included the centre in their ossification tables, without giving any detailed account of it. KÖHLER and RUCKENSTEINER both agree with SCHINZ, who has scrutinized a large number of anatomical preparations and roentgen pictures of the pelvis, without finding any support for the actual existence of an independent ossification centre in spina iliaca ant. inf. SCHINZ is in agreement with LANGER-TOLDT and gives the following final opinion: »Der selbständige Knochenkern für die Spina iliaca ant. inf. muss wohl aus der Normalanatomie gestrichen werden.»

A free ossification body at spina iliaca ant. inf. may, of course, be conceived as appearing after trauma, and KÖHLER describes one case where, owing to muscular exertion, with clear subjective symptoms, a $13^1/_2$-year old boy had a complete severance of the spina in question, which is the starting point of musc. rectus femoris. Roentgenological



Figs. 4 and 5. Schematic reproduction of the pelvis ossification according to LANGER-TOLDT (TOLDT: Anatomischer Atlas).

post examination 3 months later showed complete recovery from this injury.

This survey of the literature shows that opinions on the occurrence of a free ossification centre are somewhat divergent. In the case described above a traumatic severance of the spina can be excluded, as no local symptoms whatever were present, and no bone healing took place even during such a long period as $2^1/_2$ months. On the other hand, as both the patient's age and the roentgen pictures are in good agreement with the descriptions of the apophysis in the spina iliaca ant. inf. region of certain anatomists (WALDEYER, TESTUT), it must be assumed that such an ossification centre actually was present, although it was to one side.

A knowledge of this ossification centre, which it seems possible can appear on one side has, of course, differential diagnostic importance, even though it appears to be relatively rare.

SUMMARY

The author describes a case where a bone shadow resembling an apophysis was observed in the spina iliaca ant. inf. region in a 15-year old girl. No trauma in the anamnesis, unchanged roentgen picture $2^1/_2$ months later. After giving a short survey of the literature, the author points out that a knowledge of the existence of this ossification centre, which may appear unilaterally, is of a certain differential diagnostic value.

ZUSAMMENFASSUNG

Verf. teilt einen Fall mit, wo bei einem 15jährigen Mädchen ein apophysenähnlicher Knochenschatten an der Spina iliaca ant. inf. sin. beobachtet worden war. Kein Trauma in der Anamnese. $2^1/_2$ Monate später unverändertes Röntgenbild. Nach einem kurzen Überblick über die Literatur hebt Verf. hervor, dass die Kenntnis über diesen Kern, der unilateral auftreten kann, einen gewissen differentialdiagnostischen Wert besitzt.

RÉSUMÉ

L'auteur communique un cas, où une ombre d'os semblable à une apophyse fut observée à la Spina iliaca ant. inf. sin. chez une fillette de 15 ans. Aucun trauma dans l'anamnèse, et roentgenogramme inchangé 2 mois $^1/_2$ plus tard. Après un bref résumé de la littérature, l'auteur fait ressortir que la connaissance de ce noyau, qui peut apparaître unilatéralement, présente une certaine valeur au point de vue diagnostic différentiel.

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AUS DER RÖNTGENABTEILUNG DES ZENTRALKRANKENHAUSES IN VÄSTERÅS (SCHWEDEN).
CHEF: DR. A. RENANDER

HYPOPHYSENBESTRAHLUNG BEI CUTIS VERTICIS GYRATA[1]

von

Axel Renander

In einer früheren Arbeit mit dem Titel »Cutis verticis gyrata-Akromegalie-Osteoperiostitis hyperplastica» (Acta Radiologica Vol. XVIII, 1937, S. 652) hat Verf. nachzuweisen versucht, dass Cutis verticis gyrata keine Krankheit *sui generis* ist, sondern als ein akromegales Teilsymptom aufgefasst werden muss. Verf. wies auch darauf hin, dass der endgültige Beweis für die Richtigkeit dieser Annahme erbracht sein würde, wenn es durch Röntgenbestrahlung der Hypophyse gelänge, eine Rückbildung der hyperplastischen Veränderungen an den Weichteilen der Hände und Füsse zustandezubringen. Gleichzeitig teilte Verf. mit, dass er die Absicht habe, eine solche probatorische Bestrahlung der Hypophyse in einem Fall von Cutis verticis gyrata zu versuchen, der am Zentralkrankenhause in Västerås behandelt worden war. Im nachstehenden folgt nun ein Bericht über die Versuchsanordnungen, deren Verf. sich bediente, um Volummessungen der Hände und Füsse des Patienten vor und nach den Röntgenbehandlungen vorzunehmen, sowie über die Resultate dieser Versuchstherapie.

Bezüglich der Gesichtspunkte, die den Verf. dazu geführt hatten, Cutis verticis gyrata als ein akromegales Teilsymptom aufzufassen, sowie bezüglich der klinischen und röntgenologischen Manifestationen des Leidens sei auf die frühere, oben erwähnte Arbeit des Verf. in den Acta radiologica hingewiesen.

Versuchsanordnung

Um ein möglichst genaues Mass für das Volumen der Hände und Füsse des Patienten zu erhalten, wurde beschlossen, die Wasserverdrängung durch die Hand resp. den Fuss zu messen. Zu diesem Zweck wurde ein mit einem Ablaufhahn versehenes Schaff mit Wasser gefüllt.

[1] Bei der Red. am 24. V. 1938 eingegangen.

Nachdem der Hahn geöffnet war, liess man das Wasser abfliessen, bis auch das Tropfen aus dem Hahn aufgehört hatte. Das Niveau des Wassers befindet sich dann in gleicher Höhe mit der Abgangsstelle des Hahns (siehe Abb. 1). Nachdem dieser geschlossen war, wurde Pat. aufgefordert, seinen Fuss resp. seine Hand auf den Boden des Schaffes zu stützen, wobei das Wasser in dem Gefäss stieg, wie Abb. 2 es zeigt. Der Hahn wurde nun wieder geöffnet, wobei das Wasser wieder bis zum Niveau der Abgangsstelle sank. Die dabei abgeflossene Wassermenge

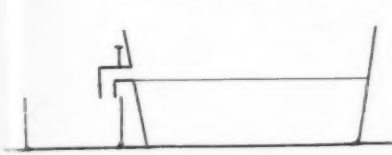

Fig. 1.

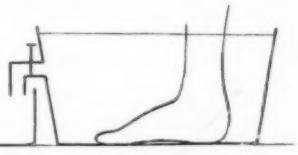

Fig. 2.

entspricht der Verdrängung durch den Fuss resp. die Hand, hat also dasselbe Volumen wie diese. Bei sämtlichen Messungen wurden ausserdem Wassertemperatur und Barometerstand vermerkt.

Versuchsresultate

Bei einer in der oben angegebenen Weise am 5. V. 1937 ausgeführten Messung des Volumens der Hände und Füsse wurden folgende Werte erhalten:

Verdrängung	durch den	rechten	Fuss	= 1,830 cm³
»	»	linken	»	= 1,790 cm³
»	die	rechte	Hand	= 1,110 cm³
»	»	linke	»	= 1,080 cm³

Die Temp. des Wassers variierte zwischen 29 und 27°. Barometerstand = 766 mm Hg.

Ausserdem wurde mittels eines gewöhnlichen Massbandes eine Messung des Umfanges der Mittelphalangen des 2.—5. Fingers und der Grundphalange des Daumens vorgenommen. Dabei ergaben sich folgende Masse.

Tabelle 1.

	Rechte Hand	Linke Hand
Daumen	10.0 cm	10.0 cm
Zeigefinger	10.25 »	9.5 »
Mittelfinger	10.0 »	9.5 »
Ringfinger	9.0 »	9.0 »
Kleiner Finger	8.25 »	9.0 »

Pat. erhielt nun eine Röntgenbestrahlung der Hypophyse von 3 Feldern (je 1 auf die rechte und linke Schläfe, Feldgrösse 6 × 6 cm, und 1 auf die Nasenwurzel, Feldgrösse 4 × 5 cm). Auf jedes Feld wurden in der Zeit vom 5. V.—5. VI. 1937 5 × 200 r durch das von THORAEUS angegebene Zinnfilter auf 30 cm Abstand gegeben.

Bei einer am 23. X. 37 vorgenommenen erneuten Messung der Verdrängung durch die Füsse unter den gleichen Versuchsbedingungen wie am 5. V. 37 wurden folgende Werte erhalten:

Verdrängung durch den rechten Fuss = 1,675 cm³
» » » linken » = 1,585 cm³.

Temp. des Wassers 29—27°. Barometerstand = 762 mm Hg.

Eine Messung des Umfanges der Mittelphalangen des 2.—5. Fingers und der Grundphalange des Daumens ergab folgendes Resultat:

Tabelle 2.

	Rechte Hand	Linke Hand
Daumen	10.0 cm	9.5 cm
Zeigefinger	9.0 »	9.0 »
Mittelfinger	9.0 »	9.0 »
Ringfinger	8.5 »	8.5 »
Kleiner Finger	8.0 »	8.0 »

Pat. bekam jetzt in der Zeit vom 23. X.—19. XI. 37 eine zweite Röntgenbehandlung, wobei dieselbe Serie gegeben wurde wie vom 2. V.—5. VI. 37. Noch eine weitere Serie von 4 × 200 r wurde vom 28. I.—10. II. 38 auf dieselben 3 Felder gegeben.

Bei einer am 26. IV. 38 in derselben Weise wie früher vorgenommenen neuerlichen Messung des Volumens der Hände betrug

die Verdrängung der rechten Hand = 980 cm³ und
» » » linken » = 885 cm³.

Temp. des Wassers 31—30°. Barometerstand = 770 mm Hg.

Messung des Umfanges der Mittelphalangen der Finger und der Grundphalange des Daumens ergab dieselben Werte wie bei der Messung am 23. X. 27.

Diese Messungen zeigen also, dass nach der 1. Röntgenserie in der Zeit vom 5. V.—23. X. 37

die Verdrängung durch den rechten Fuss um 155 cm³ und
» » » » linken » » 205 cm³

geringer geworden war. Die Variationen der Wassertemperatur und des Barometerstandes waren bei den verschiedenen Messungen so klein, dass sie unberücksichtigt gelassen werden können. Prozentuell ausgedrückt verringerte sich also in einem Zeitraum von ca. $5^1/_2$ Mon. das Volumen des rechten Fusses um 8.5 % und das Volumen des linken Fusses um 11.5 %, also im Mittelwert um 10 %. Im selben Zeitraum war auch eine beträchtliche Grössenabnahme der Hände zu konstatieren. So nahm der Umfang der Mittelphalange des rechten Zeigefingers um 1.25 cm ab (von 10.25 bis 9 cm). Auch der Umfang der übrigen Finger wurde im allgemeinen um 0.5—1 cm kleiner. Nur der rechte Daumen hatte unveränderte Masse (siehe Tabelle 1 und 2).

Nach weiteren 2 Röntgenserien wurde bei Volummessung der Hände konstatiert, dass in der Zeit vom 5. V. 37—26. IV. 38

das Volumen der rechten Hand um 130 cm^3 und das
» » » linken » » 195 cm^3

kleiner geworden war. Auch hier waren die Variationen der Wassertemperatur und des Barometerstandes so klein, dass sie nicht in Betracht gezogen wurden. Da die Messung des Umfanges der Finger zeigte, dass in dieser Beziehung seit dem 23. X. 1937 keine Veränderung vorgekommen war, dürfte man damit rechnen können, dass die konstatierte Volumabnahme schon nach der 1. Röntgenserie eingetreten war. Prozentuell ausgedrückt hatte also das Volumen der rechten Hand um 11.7 % und das Volumen der linken Hand um 12.2 % (im Mittel 12 %) abgenommen.

Die oben beschriebene probatorische Röntgenbestrahlung der Hypophyse bei einem Fall von Cutis verticis gyrata hat also im Laufe von $5^1/_2$ Mon. eine Volumverringerung der Weichteile der Hände um 12 % und der Weichteile der Füsse um 10 % herbeigeführt. Der Versuch zeigt, dass die Ursache der Krankheit in einer Störung der Hypophysenfunktion zu suchen ist. Mit den übrigen, in der vorigen Arbeit des Verf. hervorgehobenen akromegalen Symptomen zusammengestellt, dürfte es als bewiesen zu betrachten sein, dass Cutis verticis gyrata ein Symptom von Akromegalie ist.

ZUSAMMENFASSUNG

Bei vergleichenden Messungen des Volumens von Händen und Füssen vor und nach Röntgenbestrahlung der Hypophyse bei einem Fall von Cutis verticis gyrata wurde konstatiert, dass die Bestrahlung in einem Zeitraum von ca. $5^1/_2$ Mon. eine Volumabnahme der Hände und Füsse von 10 % bewirkt hatte. Dies beweist, dass das Leiden auf einer hypophysären Störung beruht. Zusammengestellt mit den übrigen, früher vom Verf. hervorgehobenen akromegalen Symptomen, ist dies nach Ansicht des Verf.

ein Beweis, dass Cutis verticis gyrata keine Krankheit sui generis ist, sondern ein acromegales Teilsymptom.

SUMMARY

By comparative measurement of the volume of the hands and feet before and after radiation of the hypophysis in a case of cutis verticis gyrata it was shown that in about $5^1/_2$ months the radiation had brought about a 10 % reduction in the volume of the hands and feet. This proves that the basis of the disease is a hypophyseal disturbance. Added to the remaining acromegalic symptoms previously reported by the author this is in his opinion a proof that cutis verticis gyrata is no disease sui generis but rather a partial symptom of acromegaly.

RÉSUMÉ

Lors de mesures comparatives du volume des mains et des pieds avant et après le traitement roentgen de l'hypophyse, dans un cas de Cutis verticis gyrata, il fut constaté que les irradiations avaient provoqué une diminution de volume des mains et des pieds de 10 %, au cours d'une période d'environ 5 mois $^1/_2$. Ceci prouve que l'affection dépend d'une perturbation de l'hypophyse. Joint aux autre symptômes acromégaliques antérieurement relevés par l'auteur, ce fait constitue, à son avis, la preuve que le Cutis verticis gyrata n'est pas une maladie sui generis, mais bien un symptôme partiel d'acromégalie.

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AUS DER RÖNTGENABTEILUNG (CHEF: PROF. H. LAURELL) UND DER CHIRURGISCHEN ABTEILUNG (CHEF: PROF. G. NYSTRÖM) DES KGL. UNIVERSITÄTSKRANKENHAUSES IN UPPSALA

ÜBER DIE DIAGNOSTIK EXTRAPLEURALER ABSZESSE[1]

von

Hans-Gösta Skarby

An der hiesigen Röntgenabteilung sind eine Reihe Beobachtungen über extrapleurale Abszesse mit tuberkulöser bzw. septischer Genese gemacht worden, über die Verfasser kurz in der Sitzung von Svensk Kirurgisk Förening am 25. 5. 1935 in Uppsala berichtet hat (siehe Referat in Nordisk Med. Tidskr. 1936, Heft 24). Unter extrapleuralen (oder uneigentlich auch »subpleuralen») Abszessen werden in diesem Zusammenhang Abszesse zwischen der Pleura parietalis und der Thoraxwand (eventuell auch ausserhalb der Fascia endothoracica) verstanden.

Da solche Abszesse meines Wissens bisher weder in der chirurgischen noch in der röntgenologischen Literatur Beachtung gefunden haben und da fünf solche Fälle auf der hiesigen Abteilung diagnostiziert worden sind, dürfte es berechtigt sein, in Kürze über sie zu berichten und anschliessend etwas auf die Symptomatologie und die Differentialdiagnose einzugehen.

Kasuistik

Fall I. K. H. A—n. Mann, geb. 22. 5. 1897 (Journal 111 und 2526/1930.)

Pat. bekam 1915 eine Eiterbildung am Rücken unmittelbar unter dem linken Schulterblatt. Dieselbe öffnete sich spontan und heilte unter ständigen ärztlichen Umlegungen im Verlauf von 3 Wochen. 1919 trat wieder Eiterbildung an derselben Stelle auf, und Pat. wurde kürzere Zeit im Serafimer-Krankenhaus in Stockholm behandelt. Vollständige Heilung erfolgte niemals: ständige Sekretion aus der Wunde und eine gewisse Steifheit der linken Schulter. In demselben Jahr entleerte sich später spontan ein Abszess, und Pat. wurde abermals im Serafimer-Krankenhaus behandelt. Neues Rezidiv 1921, dessentwegen er einen Monat auf der hiesigen Chirurgischen Abteilung behandelt wurde, wo man eine 15 cm lange Abszesshöhle auskratzte, die in der Längsrichtung der 8. Rippe verlief. Bei Röntgenuntersuchung konnten damals (auch mit Fistelfüllung) keine Veränderungen an Rippen, Scapula oder Proc. spinosi konstatiert werden.

[1] Bei der Red. am 26. IV. 1938 eingegangen.

1924 wurde Pat. auf der hiesigen Chirurgischen Abteilung 5 Wochen unter der Diagnose *Osteitis tbc? costae III sin. cum abscessu* behandelt.

Bei Röntgenuntersuchung mit Lipiodolfüllung der Fistel wurde festgestellt, dass die Abszesshöhle in der Höhe des Angulus scapulae mit einem breiten Fistelgang direkt an den Rippen kommunizierte, der sich nach oben bis C. III erstreckte. Keine sicheren Knochenherde sichtbar, jedoch *vermutlich eine oberflächliche Usur hinten-lateral an C. III. Nach innen von dieser eine schmale spindelförmige Auftreibung der Pleura parietalis, die sich gegen die Lunge vorwölbte (subpleurales Empyem?)*. Wurde mit geheilter Fistel entlassen.

Beschwerdenfrei bis Weihnachten 1927, als heftige Schmerzen in der linken Schulter aufzutreten begannen. Im Februar 1928 bemerkte Pat. einen empfindlichen Tumor an der alten Stelle, der an Grösse zunahm. Aufnahme in die hiesige Chirurgische Abteilung am 20. 3. 1928. Am folgenden Tag wurde graugelber, dickflüssiger Eiter aus dem Abszess entleert. Röntgen an demselben Tage zeigte keine sicheren Veränderungen in Wirbelsäule, Rippen oder Schulterblatt.

Am 23. 3. erfolgte Auskratzung der Höhle von einem Schnitt aus, der parallel zu und medial von dem medialen Rande der Scapula gelegt wurde. Der Abszess war mit typischen tuberkulösen Granulationen bekleidet und erstreckte sich nach oben bis unmittelbar über die Spina scapulae und auch unter das Schulterblatt. Die Wände des Abszesses bestanden aus schwartigem Bindegewebe. Ein sicherer Knochenherd wurde nicht angetroffen, aber am Angulus costae II zeigte der Knochen eine rauhe Oberfläche. Nach sorgfältiger Auskratzung wurde die Höhle mit Jodspiritus ausgewaschen und ein Röhrchen in sie eingelegt. Im übrigen Primärsutur.

Nach 2-wöchigem Krankenhausaufenthalt wurde Pat. so gut wie geheilt entlassen. Zwei Monate später war er vollständig geheilt und blieb bis 1930 gesund. Während dieser Zeit war er wie gewöhnlich mit schwerer Arbeit beschäftigt. *Neujahr 1930* wurde er wieder in die Chirurgische Abteilung aufgenommen, nachdem er einen Monat bei der Arbeit Beschwerden in Form eines Spannungsgefühls in der linken Schulter gehabt hatte. Unbedeutende Schmerzen mit etwas örtlicher Empfindlichkeit.

Röntgen zeigte auch jetzt keine sicheren Skelettveränderungen ausser den früher beobachteten. In der Höhe des linken Angulus scapulae, medial von diesem, eine walnussgrosse, fluktuierende Anschwellung mit geröteter Haut. Fünf Tage nach der Aufnahme Exzision der alten Narbe. Freipräparierung einer 12 cm langen Fistel, »ausgehend von der 4. Rippe» (in Wirklichkeit von der 3., siehe unten), unter dem Schulterblatt. *Die Rippe wies in einem kleinen Gebiet eine rauhe, periostfreie Oberfläche auf.* Man reseziert ca. 5 cm der Rippe. Dränage mit einem Röhrchen. Im übrigen Sutur.

Nach 1-monatigem Krankenhausaufenthalt Entlassung zu weiterer Behandlung einer kleinen, zurückgebliebenen Fistel. Pat. fühlte sich bald gesund und tat dann schwere Arbeit bis September 1930, als er sich wegen einer Anschwellung in der linken Axille wieder an die hiesige Chirurgische Abteilung wandte.

Bei der Aufnahme am 9. 9. 1930 war der Allgemeinzustand des Patienten gut. Nichts Bemerkenswertes seitens der inneren Organe. In der linken Axille ein grosses Konglomerat von bis walnussgrossen fluktuierenden, aber nicht empfindlichen Drüsen.

Röntgen 10. 9.: »Nun tritt eine tuberkulöse Osteitis mit ein paar etwa braunbohnengrossen Herden in der 4. Rippe auf der linken Seite zwischen der Skapular- und der Axillarlinie hervor. Von der 3. Rippe ist ein Stück, das die Skapularlinie schneidet, reseziert. Lungen emphysematös mit ein wenig Verkalkung in den Hili. Lateral in R. 2 eine Gruppe kleine Flocken. Lateral hinten unmittelbar unter der Klavikelebene ein *extrapleuraler Abszess*, der die Pleura parietalis vorwölbt.» (Fig. 1.)

Operation 15. 9.: Schnitt in der alten Narbe. Muskelgewebe schwartig durchsetzt. Erst nachdem man die Lage sämtlicher oberen fünf Rippen anatomisch genau festgestellt

hat[illegible], war eine richtige Orientierung möglich. Dicht unt[illegible] der Scapula glaubte man die auf dem Röntgenbil[illegible] sichtbaren Herde an der 4. Rippe zu palpieren. Be[illegible] der vorigen Operation war offenbar die dritte, nic[illegible] die vierte Rippe, reseziert worden. Resektion ein[illegible] 7 cm langen Stückes der 4. Rippe mit Periost.

(In dem Operationsbericht steht nichts über tie[illegible] liegende Teile, die offensichtlich unberührt gel[illegible]sen wurden.)

Am 23. 9. 1930 wurde Pat. per primam geheilt ent[illegible]ssen. Die Drüsenschwellung in der Axille war dan[illegible]is nach Röntgenbehandlung fast vollständig zur[illegible]kgegangen.

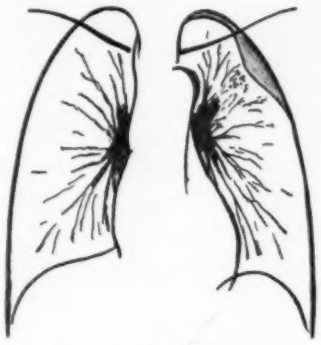

Fig. 1.

Fall II. J. M. L—m. Mann, geb. 1903 (Journal 51 und 835/1925).

Für die Eltern ist keine tuberkulöse Exposition oder Heredität bekannt. Pat. hatte als Kind Rachitis. Weihnachten 1919 Luftröhrenkatarrh (kein Stechen), nach 2-wöchiger Bettruhe symptomfrei. Im Sommer 1923 Luftwegsinfektion, Schmerzen in der Brust, aber kein nennenswertes Krankheitsgefühl; konnte in Arbeit gehen. Nach einigen Wochen beschwerdenfrei.

Ende Juli 1924 bohrender Schmerz in der rechten Seite am Übergang zwischen dem Knorpel und dem Knochen der 6. Rippe. $1^1/_2$ Monate später (September) begann dieses Gebiet anzuschwellen, und Mitte November desselben Jahres entleerte sich übelriechende Flüssigkeit. Wurde zu zwei verschiedenen Malen auf der Chirurgischen Abteilung des Universitätskrankenhauses behandelt:

a) *3. 12. 1924—3. 1. 1925.* Guter Allgemeinzustand. Keine Temperaturerhöhung. Herz und Lungen zeigen physikalisch nichts Bemerkenswertes.

Lungenröntgen 3. 12.: »Linke Lunge ohne sichtbare Veränderungen. Auf der rechten Seite infraklavikulär und basal tuberkuloseartige Flocken. Starke Verschleierung supraklavikulär, wahrscheinlich infolge von Pleuraschwarten. Pleuraschwarte zwischen Ober- und Mittellappen. Kleines Pleuraexsudat basal-lateral, wahrscheinlich in der Hauptsache Schwarten, aber ein kleines flüssiges Exsudat ist nicht ausgeschlossen. Knochen-Knorpel-Grenze an der 4. und 6. Rippe unregelmässig, aber keine *sicheren* Knochenherde sichtbar. Diagnose: Wahrscheinlich besteht eine Tub. pulm. sowie eine hauptsächlich schwartenbildende Pleuritis. Osteitis ist nicht ausgeschlossen».

Entsprechend der Knorpel-Knochen-Grenze wurde eine hier und da deutlich fluktuierende Auftreibung festgestellt, die eine zentrale Ulzeration mit glatten, teilweise unterminierten Wundrändern aufwies. Im Eitersekret keine Tuberkelbazillen.

Operation 5. 12.: Resektion eines Teiles der 6. Rippe, entsprechend der angegriffenen Partie. In dieser fand man einen haselnussgrossen Herd, der ein für Tuberkulose typisches Sequester enthielt. Von dem Herde gingen Fisteln teils nach oben, teils medialwärts, die in gut abgegrenzte Abszesse mündeten, welche ausgeräumt und tamponiert wurden. Im übrigen Sutur.

Fast geheilt entlassen.

Nach rheumatoiden Schmerzen in verschiedenen Teilen des Körpers sowie einwöchigen Schmerzen in der rechten Schultergegend kam Pat. am 1. 4. 1925 wieder.

b) *1. 4. 1925—6. 6. 1925.* Pat. hat in den letzten 2 Wochen eine Anschwellung am vorderen Teil der Brust rechts vom Sternum, oberhalb der Mamille gehabt, sowie ausserdem auch eine Anschwellung nach dem Deltoideusmuskel und der rechten Seite des Halses

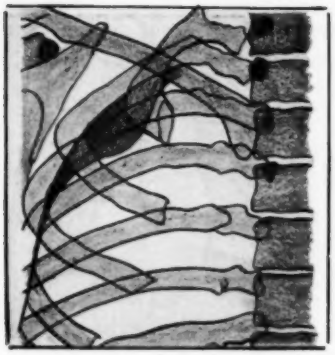

Fig. 2.

hinauf. Die letztgenannte Anschwellung war i[n] ies zurückgegangen, als Pat. ins Krankenhaus [ei]n. Kein Fieber bei der Aufnahme. Allgemeinzus[tan]d ziemlich gut, jedoch sparsames Fettpolster. Im rechten Teil des Thorax fand man nun ausser [d]ier alten, recht verfärbten, aber völlig geheilten N[a]be über der 6. Rippe auch eine fast kreisrunde, r[ei]drige Auftreibung um die Knorpel-Knochen-Gr[e]nze der 2. und 3. Rippe. Durchmesser des Tu[m]ors 8 cm. Keine Rötung der Haut, die auch nich[t] am Tumor fixiert ist. Dieser ist stark fluktuierend [u]nd in der Tiefe befestigt. Empfindlichkeit bei D[r]uck auf die Knorpel-Knochen-Grenzen der 1.—3. R[i]ppe.

Röntgen 2. 4.: »Kein sicherer Knochenherd sichtbar, aber in der Gegend der 2. Rippe sieht man eine Einbuchtung der Pleura, *wahrscheinlich infolge subpleuraler Eiteransammlung* (tuberkulöser Abszess).» (Fig. 2 und 6.)

Operation 4. 4.: Resektion von makroskopisch veränderten Teilen der 1. und 2. Rippe vorn. Nachdem reichlicher tuberkulöser Eiter aus der Abszesshöhle entleert worden war, stellte sich heraus, dass sich diese nach oben hinten bis zur Axille und an dieser vorbei hinter das Schulterblatt fortsetzte. Sämtliche Granulationen wurden mit dem Löffel ausgekratzt. Die ganze Wundhöhle wurde mit Jodspiritus ausgewaschen. Röhrchen. Sutur.

Das Röhrchen wurde nach 2 Tagen herausgenommen. Normale Temperatur nach einer Woche. Die ganze Zeit über guter Allgemeinzustand. Bei der Entlassung war Pat. fast geheilt.

Weitere Angaben fehlen.

Fall III. B. R. L—m. Knabe, geb. 20. 10. 1920 (Journal 1779/1928).

Behandlung auf der Chirurgischen Abteilung 3. 7.—23. 7. 1928. Bisher gesund. Keine tuberkulöse Heredität, aber ein paar Jahre vor der Aufnahme ins Krankenhaus hatte sich Pat. etwa eine Woche bei einer tuberkulösen Person aufgehalten. Ohne bekannten Anlass entstand 2 Monate vor der Aufnahme ins Krankenhaus in der vorderen Axillarlinie auf der rechten Seite eine Anschwellung. Diese war allmählich gewachsen und hatte ausser unbedeutendem Schmerz am Tage keine nennenswerten Beschwerden verursacht.

Bei der Aufnahme ausgezeichneter Allgemeinzustand. Puls und Temperatur normal. Oberflächliche Lymphdrüsen nicht vergrössert. Schlund blass, Tonsillen etwas vergrössert. Lungen und Bauch ohne physikalische Veränderungen. Das Herz zeigte nur basal eine Akzentuierung der beiden Töne.

Örtlich: Über der Gegend der 7. und 8. Rippe in der vorderen Axillarlinie eine hühnereigrosse fluktuierende Vorwölbung mit einem festeren Wall in der Peripherie. Die Anschwellung ist nicht druckempfindlich und die Haut darüber nicht verändert. Punktion der Anschwellung ergab 20 ccm braungrüne dicke Flüssigkeit, die kleinere Fibrinflocken enthielt.

Röntgen am 5. 7. 1928: »Ein Abszess in der rechten Flanke, der sich sowohl nach aussen unter die Muskeln als in die Lunge wölbt und wahrscheinlich von einer Osteitis in der 8. Rippe ausgegangen ist, an deren Aussenseite man ein kleines Sequester bemerkt.» (Fig. 3.)

Bei darauf vorgenommener Operation wurde der Abszess gespalten. Die Abszessmembran wurde exzidiert. Auskratzung von Granulationen und Resektion der 7. und 8.

Ri[illegible]e in einer Länge von ca. $4^1/_2$ bzw. 6^1[illegible]m. In der Tiefe wurde der intrathorakale Teil des Abszesses angetroffen, gefüllt mit gesprenkelten Granulationen und dünnem wässriger Flüssigkeit. Sorgfältige Auskratzung der Höhle, auf deren Grunde die verdickte, schwartige, unbeschädigte Pleura parietalis bloss lag. Das auf dem Röntgenbild sichtbare Sequester wurde nicht gefunden. Makroskopisch: Tuberkulöse Osteitis. Sutur und ein Röhrchen.

Die Operation hatte den Patienten recht angegriffen, aber er erholte sich rasch und wurde am 23. 7. 1928 geheilt entlassen.

Bei Untersuchung am 23. 9. 1936 wies Pat. eine mässige arterielle orthostatische Anämie auf, war aber im übrigen gesund.

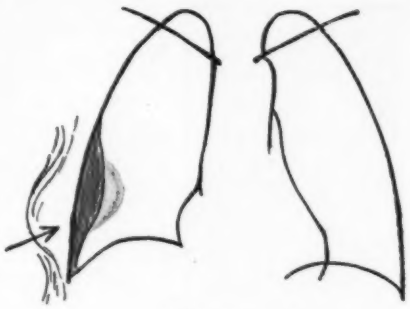

Fig. 3.

Röntgen der Lungen: »Keine Zeichen von Tuberkulose».

Fall IV. K. V. S—s. Mann, geb. 1906 (Journal 2321 und 2404/1932).

Eine Schwester der Mutter des Patienten ist an Tuberkulose gestorben. Pat. hatte als Kind Masern und Keuchhusten. 1921 Polyarthritis (mit Affektion des rechten Hüftgelenks, des rechten Ellbogengelenks sowie der Metakarpophalangeal- und der Interphalangealgelenke der linken Hand).

Bekam unmittelbar nach der Polyarthritis Pyämie und Osteomyeliten im rechten Radius und linken Humerus sowie Abszesse im rechten Oberschenkel, im linken Ringfinger sowie auf der Aussenseite des rechten Darmbeins, ungefähr 1 cm unterhalb der Crista iliaca, jedoch ohne Veränderungen des unterliegenden Knochens. Die Osteomyeliten wurden ausgemeisselt und die Abszesse geöffnet. Mikroskopische Untersuchung ergab Staphylokokken.

Pat. war dann in der Hauptsache gesund.

Bei Lungenuntersuchung hier im Dezember 1931 wurde auf dem Röntgenbild *ein alter Osteitisherd in der 5. Rippe subskapulär auf der linken Seite* festgestellt. Um diesen Herd eine spulförmige Auftreibung der Rippe sowie nach innen von ihr eine Verdickung der Pleura.

Am 2. 9. 1932 hob Pat. einen schweren Koffer. Zunächst spürte er kein Unbehagen aber 3 Tage später (am Tage vor der Aufnahme in das Universitätskrankenhaus) erwachte Pat. mit leichter Empfindlichkeit in der Gegend des linken Schulterblattes. Er tat jedoch diesen ganzen Tag seine Arbeit.

An demselben Tage, an dem Pat. aufgenommen wurde, fühlte er beim Atmen eine Friktion zwischen den Pleurablättern (Pat. ist Kandidat der Medizin). Er suchte nun die hiesige chirurgische Poliklinik auf, wo eine begrenzte trockene Pleuritis unter dem linken Schulterblatt konstatiert wurde.

Bei der Aufnahme in die Chirurgische Abteilung am 6. 9. 1932 war der Allgemeinzustand des Patienten nicht beeinträchtigt. Keine Ödeme. Keine Zyanose. Normal entwickeltes Fettpolster. Leichte Atrophie der Muskulatur des rechten Oberarms. Muskulatur sonst gewöhnlich. Allgemeine Hautfarbe o. B. Temp. 38°.8, Puls 104.

Oberflächliche Lymphdrüsen, Thyreoidea, Mundhöhle und Schlund o. B.

Pulmones: Keine Dämpfung, vesikuläres Atmungsgeräusch. Keine Reibungsgeräusche.

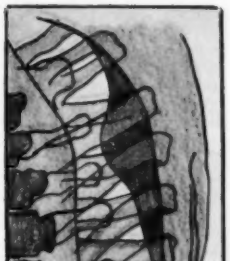

Fig. 4.

Cor: Breite 3 + 8 cm. Iktus nicht distinkt palpabel. Schwaches systolisches Blasgeräusch über dem ganzen Herzen. Keine Arhytmie.

Bauch, Harn, Reflexe: o. B.

Weisse Blutkörperchen: 7,300, davon 5,000 polynukleäre.

Lokalstatus: Leichte Empfindlichkeit über der linken Schulterblattgegend. Leichte, aber deutliche Anschwellung der Skapularmuskulatur. Keine oder unbedeutende Empfindlichkeit bei Bewegungen der linken Scapula.

Die Senkungsreaktion betrug am 9. 9.: 84 mm. Die Temperatur sank rasch, und die örtlichen Erscheinungen gingen zurück. Wurde am 12. 9. völlig beschwerdenfrei und ohne örtliche Erscheinungen entlassen.

Er arbeitete am 13. und 14. 9. wie gewöhnlich auf der Medizinischen Poliklinik, fühlte aber an 14. nachmittags einen dumpfen Schmerz in der linken Schulterblattgegend. In der folgenden Nacht schlief er unruhig und fühlte sich am nächsten Morgen fiebrig.

Erneute Aufnahme in die Chirurgische Abteilung am 15. 9. (Entlassung am 19. 10.). Bei der Aufnahme nicht beeinträchtigter Allgemeinzustand, Temperatur 38°.2. Leichte Schwellung in der linken Schulterblattgegend. Keine deutliche palpatorische Empfindlichkeit.

Während der nächsten Woche sank die Temperatur ständig, aber nicht auf ganz normale Werte. Die Schmerzen und die Schwellung verschwanden.

Röntgenuntersuhung am 7. 9. hatte ein in der Hauptsache unverändertes Bild gegenüber dem 9. 12. 31 gezeigt (Fig. 4 und 7).

Am 23. 9. fühlte sich Pat. kalt und bekam Hustenreiz, der auch am nächsten Tage anhielt. Keine Sputa. Nachtschweiss. Von den Lungen nichts Physikalisches. Der Husten nahm allmählich ab, am 30. 9. kleines, zähes Expektorat (ohne Tuberkelbazillen), die Temperatur sinkt langsam.

Am 5. 10. ist notiert, dass die Symptome seitens der Atmungswege verschwunden sind. Temperatur noch nicht ganz normal. Senkungsreaktion 98 mm.

Röntgenuntersuchung am 10. 10. 1932 zeigt ein in der Hauptsache unverändertes Bild. Ein Sequester ist im Rippenherd nicht zu bemerken.

Wegen der hartnäckigen subfebrilen Temperatur und der steigenden Senkungsreaktion, die auf einen schwelenden örtlichen Herd, offenbar in der 5. Rippe deuteten, erfolgte am 10. 10. 1932.

Operation (Prof. NYSTRÖM): Längsschnitt längs dem medialen Rande des linken Schulterblatts in einer Länge von etwa 7 cm. Durchschneidung der Muskulatur längs dem Schulterblattrand und Freilegung des Herdes, der sich durch eine palpable Einsenkung im unteren Rande der 5. Rippe zu erkennen gab. Nachdem man die Interkostalmuskulatur längs dem Unterrande der Rippe an dieser Stelle durchschnitten hatte, kam man in eine vor der Rippe liegende pflaumengrosse Höhle, gefüllt mit dicken, grauweissen, teilweise schleimigen, teilweise käsigen Massen, die gründlich mit dem Löffel herausgeschafft wurden. In der Höhle fand sich kein Sequester. Die Höhlenwände waren glatt, ebenso die Oberfläche des Knochens in dem erwähnten Randdefekt, der einen Teil der Höhlenbegrenzung bildete. Man legte ein Dränröhrchen in die Höhle und nähte die Wunde um dasselbe zusammen.

Pathologisch-histologische Untersuchung: »Unspezifische Granulationen — die Probe besteht teils aus kompaktem Bindegewebe, teils aus zell- und gefässreichem, frischerem und älterem Granulationsgewebe, in dem man zahlreiche Makrophagen sieht. Keine Zeichen von Tuberkulose oder Tumor» (GELLERSTEDT).

Fast keine Temperaturreaktion nach der Operation. Die ganze Zeit über afebril. Am 9. 10. konnte Pat. völlig geheilt entlassen werden. (Es hatte so gut wie keine Sekretion von der Dränagestelle stattgefunden.)
Seitdem hat Pat. keine Thoraxbeschwerden gehabt.

Fall V. F. H—n. Mann, früher stud. phil., geb. 1897.

Bisher in der Hauptsache gesund, hat keinen Husten und keine Brustfellentzündung gehabt. War immer mager und ist in der letzten Zeit nicht besonders abgemagert. Ungefähr einen Monat vor der Aufnahme in die Chirurgische Abteilung bemerkte er Schwäche im Rücken; er musste sich mit den Händen auf die Knie stützen, wenn er sich aus vorgebeugter Stellung erheben wollte. Ein wenig später beobachtete er eine Ausfüllung links vom Rückgrat in der Höhe der unteren Brustwirbel. Diese Ausfüllung hat seitem zugenommen und sich allmählich nach der Lendenwirbelsäule gesenkt, wo sie ständig gewachsen ist. Keine Schmerzen, keine Parästhesien.

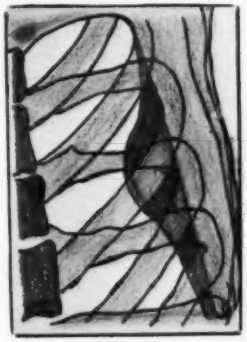

Fig. 5.

Bei Aufnahme in die Chirurgische Abteilung am 18. 3. 1935 war der Allgemeinzustand des Patienten deutlich beeinträchtigt. Er war sehr mager und blass. Cor: Keine Vergrösserung noch Verschiebung. Reine, rhythmische Töne. Pulmones: Über der ganzen linken Lunge mässige Dämpfung — siehe Lokalstatus — aber normales Atmungsgeräusch. Keine Rasselgeräusche hörbar. Bauch weich und unempfindlich.

Lokalstatus: Links vom Rückgrat erstreckt sich von den obersten Brustwirbeln bis zur Crista ilei eine Ausfüllung, die in der Höhe der Brustwirbel in einem 3—4 Finger breiten und ebenso tiefen, fluktuierenden Gebilde besteht; dieses erweitert sich in der Gegend der Lendenwirbelsäule rasch zu einem doppelt faustgrossen, fluktuierenden Tumor, über dem die Haut gerötet und dünn ist. An dieser Stelle liegt also der Abszess unmittelbar unter der Haut, weiter oben liegt er mehr in der Tiefe. Keine Empfindlichkeit über den Dornfortsätzen der Wirbel.

Röntgen am 19. 3. 35: »Tub. costarum c. abscessu. Hals-, Brust- und Lendenwirbelsäule ohne Zeichen von tuberkulöser Spondylitis. Lungen emphysematös, ohne Anzeichen eines aktiven Parenchymprozesses. Pleuraschwarte und kleinere, gut abgegrenzte Randflocken an der linken Spitze. — In der Höhe der 6. und 7. Rippe findet sich auf der linken Seite ein hühnereigrosser Schatten, der, wie sich bei Drehung zeigt, von der Thoraxwand ausgeht und sich gegen die Lunge vorwölbt (*subpleuraler Abszess*). Am hinteren Umfang der 5., 6. und 7. Rippe, teilweise in den Teilen, die von der Skapula bedeckt werden, bemerkt man eine Anzahl Knochenherde bis zur Grösse einer spanischen Nuss«. (Fig. 5 und 8.)

Während der nächsten zwei Wochen wurden einige Punktionen mit grober Spitze gemacht, wobei grosse Eitermengen ausgesaugt wurden. Im Zusammenhang mit jeder Punktion wurde die Höhle mit Rivanollösung ausgespült und der Abszess dabei so gut wie vollständig entleert.

In direktem Anschluss an einen solchen Eingriff erfolgte am 1. 4. 1935.

Operation (Dozent SCHILDT): Resektion der 4.—7. Rippe, Auskratzung, Jodätzung. Chloräthyl-Äthernarkose. Schnitt zwischen dem Schulterblatt und dem Rückgrat. Die veränderten Rippen werden freigelegt, aber auf der Aussenseite sieht alles normal aus. Bei Resektion der 6. Rippe wird ein hühnereigrosser, mit tuberkulösem Eiter und tuberkulösen Granulationen gefüllter Abszess geöffnet. Darauf werden auch die 4., 5. und

7. Rippe reseziert. Die 4. Rippe ist, soweit man sehen kann, unverändert. Hinte den übrigen findet man ein Abszessystem. Unterhalb der 7. Rippe und im Anschluss a sie besteht eine Verbindung mit dem grossen Senkungsabszess in der Höhe der Le lenwirbelsäule. Die Rippen werden subperiostal, von den Costotransversalgelenken ach aussen, in einer Länge von 6—7 cm reseziert.

Die Abszesse werden gründlich ausgekratzt und möglichst viel tuberkulöses Ge ebe exzidiert. Stellenweise kommt man in der Tiefe in unmittelbaren Kontakt mit der L nge. Die Pleura wird indes, soweit sich beobachten lässt, nicht verletzt. Hierauf w scht man die sichtbaren Tuberkulosehöhlen mit Jodspiritus aus. Sorgfältige Blutstil ung. Die lange Verbindung mit dem Senkungsabszess wird, so weit man gelangen kann, mit dem Löffel ausgekratzt und mit Jod gepinselt. In dem Abszess befinden sich reichliche Mengen käsiger Massen, die ausgedrückt werden können. Man kann die Wunde nicht primär schliessen, sondern hält es — wegen der grossen Wundhöhlen — für nötig, trotz der Fistelgefahr mit feinen Röhrchen zu dränieren. Während der Operation ziemlich reichliche Blutung aus dem von Schwarten umgebenen, gefässreichen Gewebe. Pat. überstand den Eingriff gut.

Pathologisch-histologische Untersuchung der Granulationen: »Tuberkulose — typische tuberkulöse, teilweise käsig verwandelte Granulationen, die an den Faszien und der Skelettmuskulatur haften und in sie eindringen. Die letztere ist atrophisch und ödematös» (GELLERSTEDT).

Die Operationswunde schien erst primär heilen zu wollen. Indes bildete sich dort ein Abszess, der mehrmals punktiert wurde; auch die Wunde selbst sezernierte etwas. Schliesslich trat jedoch rasche Besserung ein, und Pat. konnte am 20. 6. 1935 geheilt und gesund entlassen werden.

Er war seitem symptomfrei, abgesehen von einer gewissen Steifheit des linken Armes, bis er Anfang Februar 1937 eine empfindliche Ausfüllung auf der linken Rückenseite bekam. Diese nahm rasch an Grösse zu, und nachdem die Symptome eine Woche bestanden hatten, wurde Pat. auf seinen Antrag am 11. 2. 37 in die hiesige Chirurgische Abteilung aufgenommen.

Pat. wurde hier ungefähr einen Monat behandelt. Sein Allgemeinzustand war ziemlich gut. Auf der linken Seite des Rückens, von der Medianlinie bis zur hinteren Axillarlinie, eine recht diffus begrenzte Ausfüllung mit zentraler Fluktuation und festerer Peripherie. Typischer kalter Abszess.

Röntgen am 12. 2. 1937 zeigte keinen neuhinzugekommenen Prozess im Lungenfeld. Der Thorax wies Operationsdefekte an der linken 4—7. Rippe auf, dagegen waren in den restierenden Teilen der Rippen, ausser deformierenden Kallusbrücken, keine Veränderungen zu bemerken.

Nach einigen Punktionen, wobei höchstens 25 ccm Eiter (ohne Bakterien) entleert wurden, und anschliessenden Rivanolspülungen wurde Pat. bedeutend gebessert zu weiterer poliklinischer Behandlung mit Lichtbädern entlassen. Die Senkungsreaktion hielt sich um 27—28 mm in der Stunde.

Es hat sich hier also um 5 Fälle von extrapleuralem Abszess gehandelt, von denen 4 auf tuberkulöser und 1 auf Staphylokokkeninfektion (Fall IV) beruhten.

Es ist nicht meine Absicht, hier näher auf die Genese dieser Affektionen einzugehen. Viele Autoren geben an, dass Rippentuberkulose oft sekundär im Anschluss an eine tuberkulöse Pleuritis auf derselben Seite auftritt. Dieser Verlauf ist nach ISELIN (QUERVAIN) die Regel. Jedoch ist es wohl im allgemeinen schwierig, sich bestimmt darüber zu äussern,

Fig. 6.

Fig. 7.

was in solchen Fällen das Primäre ist. Gegen die erwähnte Ansicht liesse sich einwenden, dass es eigentümlich ist, dass Rippentuberkulose am häufigsten in den vorderen Teilen der mittleren Rippen auftritt (siehe unten), also in Teilen, die am wenigsten von Pleuriten in Mitleidenschaft gezogen werden.

Was die Diagnose extrapleuraler Abszesse betrifft, so gibt die *Anamnese* wertvolle Aufschlüsse in den Fällen, wo Pat. früher septische Affektionen im Skelett oder anderswo gehabt hat, oder — soweit es sich um tuberkulöse Abszesse handelt — wo er eine tuberkulöse Pleuritis auf derselben Seite, einen tuberkulösen Skelettherd usw. gehabt hat. Der Krankheitsverlauf selbst ist bei septischem, extrapleuralem Abszess durch dieselben Symptome gekennzeichnet wie bei gelichartigen septischen Prozessen im allgemeinen (= septische Osteomyeliten). In tuberkulösen Fällen andererseits ist der relativ schmerzfreie Beginn des Prozesses typisch; ein oberflächlicher Senkungsabszess ist oft das erste Symptom, das der Patient bemerkt. Das Nichtvorhandensein einer kürzlich

Fig. 8.

durchgemachten Pneumonie gibt einen wichtigen Fingerzeig, da eine der schwierigsten Differentialdiagnosen die gegenüber meta- oder postpneumonischen Empyemen ist. Im Zusammenhang mit der Entwicklung des extrapleuralen Abszesses können sich Pleuritisreizung und Hustenreiz einstellen (Fall IV).

Die örtlichen Erscheinungen weisen gewöhnlich eindeutig auf einen Prozess hin, der seinen Sitz in oder an der Thoraxwand hat, mag es sich nun um einen septischen oder einen tuberkulösen Prozess handeln. Die Diagnose ist dann verhältnismässig leicht, wenn der Prozess in von Muskulatur wenig bedeckten Teilen des Thorax lokalisiert ist. Schwieriger ist die Diagnose, wenn der Prozess einen versteckten Sitz hat, z. B. unter dem Schultergürtel, oder wenn er sich nur subkostal entwickelt. Die Symptome sind dann diffuser, und die Diagnose kann kaum ohne positiven Befund bei Röntgenuntersuchung gestellt werden.

Hat man auf einem gewöhnlichen Frontalbild bei Röntgenuntersuchung der Lungen eines Patienten einen Schatten von ungewisser Art

beobachtet, der u. a. ein Abszess von irgendwelcher Natur sein könnte, so muss man, indem man den Patienten unter Durchleuchtung dreht, zu ermitteln suchen, ob der Schatten in Verbindung mit der Thoraxwand steht.

Wenn dies der Fall ist, ist es von Wichtigkeit, ein gutes Profilbild des Schattens aufzunehmen, so dass also die Röntgenstrahlen die Thoraxwand gerade da tangieren, wo der Prozess sich befindet. Handelt es sich um einen extrapleuralen Abszess, so kann man auf dem Profilbild eine äusserst charakteristische Kontur gegen die Lunge wahrnehmen (Fig. 1—5, siehe unten). Die Konfiguration dieser Kontur muss natürlich bei verschiedener Neigung des Patienten konstant sein.

Auch die Lokalisation selbst kann einen gewissen Anhaltspunkt für die Diagnose bieten. In der Regel dürfte man nicht mit anderen Entstehungsmöglichkeiten extrapleuraler Abszesse zu rechnen brauchen als mit Rippenherden. Deshalb ist es für eine wirksame Therapie von Wichtigkeit, dass man bei der Röntgenuntersuchung auch solche Herde an dem Abszess aufspürt und ihre Lage aufnimmt. Tuberkulöse Rippenveränderungen treten nach KIRSCHNERS Angabe in seinem grossen chirurgischen Handbuch vor allem in der 4.—8. Rippe auf, gewöhnlich in den vorderen Partien am Übergang zum Knorpel. Dort wird auch auf die Tatsache hingewiesen, dass solche Herde selten die Pleura durchbrechen, da die Schwartenbildung gleichen Schritt mit der Entwicklung des Prozesses hält. In demselben Handbuch wird das gleiche Verhalten bei septischen Rippenprozessen hervorgehoben; KIRSCHNER referiert einen von TRENDEL beschriebenen Fall, wo bei der Sektion festgestellt wurde, dass ein septischer Rippenherd die Ursache eines kleinen, sich in die Lunge vorwölbenden Abszesses war.

Die septischen Rippenherde sind selten multipel, sie sitzen gewöhnlich auf der rechten Seite, meist am Angulus costae oder am Übergang zwischen Knochen und Knorpel (KIRSCHNER).

Theoretisch kann man sich natürlich auch andere Entstehungsarten extrapleuraler Abszesse denken, z. B. direkt hämatogen-metastatische (alsdann am wahrscheinlichsten bei septischen Affektionen) oder direktes Übergreifen einer adhäsiven Pleuritis auf das extrapleurale Bindegewebe ohne gleichzeitige Affektion der Rippen usw.

Bei anderen Lokalisationen, z. B. nahe dem Rückgrat, ist die Diagnose natürlich erheblich schwieriger — es können dann Bilder entstehen, die in vielen Fällen Senkungsabszessen bei einer tuberkulösen Spondylitis, dissezierenden Aneurysmen, paravertebralen Exsudaten, paravertebralen und paramediastinalen Tumoren usw. gleichen. Ebenso ergeben sich natürlich diagnostische Schwierigkeiten, wenn der Prozess nahe dem Sternum liegt — eine Lage, bei der Prozesse verschiedener Art im all-

gemeinen relativ schwer zu diagnostizieren sind (Tumoren, Exsudate, infiltrierende Prozesse überhaupt u. a.).

Abgekapseltes Pleuraexsudat, vor allem Empyem, ist differentialdiagnostisch die wichtigste Affektion. Hier ist darauf hinzuweisen, dass solche Exsudate in der Regel erheblich grösser sind als extrapleurale Abszesse. Da die Exsudate gewöhnlich anfangs frei sind, pflegen sie, wenn sie später abgekapselt werden, oft mit ihrem niedrigsten Punkt das Zwerchfell zu erreichen (Fig. 9). Ein extrapleuraler Abszess dagegen befällt seltener den untersten Teil des Thorax. Das soeben Gesagte bedeutet jedoch keine absoluten Unterschiede zwischen den beiden Krankheitsgruppen. *Am wichtigsten ist die für den extrapleuralen Abszess so typische Kontur auf dem Profilbild.* Bei dem Empyem ist die Kontur in der Regel konvex gegen die Lunge; bei dem extrapleuralen Abszess ist der zentrale Teil konvex, die Seitenpartien konkav (siehe Figg. 1—5). Bei sehr grossen abgekapselten Pleuraexsudaten *kann* die Grenze gegen die Lunge infolge Atelektase des benachbarten Lungengewebes unscharf werden (Sergent, Bordet u. a.). Dies ist bei den extrapleuralen, subkostalen Abszessen nicht der Fall. Ist die das Pleuraexsudat umgebende Schwarte dünn und ausserdem schlaff (oder bei niedrigem Druck im Exsudat und geringer Retraktionskraft des Lungengewebes), kann allerdings die Kontur bisweilen *nach oben* abklingen, ebenso wie bei extrapleuralem Abszess, aber der untere Teil des Exsudats wölbt sich dann gleichzeitig mehr sackförmig in die Lunge vor (Fig. 10).

Ein kleines Pleuraexsudat, das weiter oben abgekapselt ist, beruht gewöhnlich auf einer Pleuropneumonie. In solchem Fall hat man ausser dem Aussehen der Kontur (konvexe Grenze des Schattens gegen die Lunge) auch Pneumoniereste am Exsudat, Interlobärexsudat sowie vor allem die Anamnese und das klinische Bild zu beachten. Natürlich ist es denkbar, dass die Lungenpartie zunächst einem extrapleuralen Abszess kollaterale Reizungserscheinungen mit einer gewissen Hyperämie aufweist, aber dann muss das Bild ein anderes sein als bei im Rückgang begriffener Pleuropneumonie mit abgekapseltem sekundärem Empyem (Fig. 11).

Vielleicht sind in diesem Zusammenhang auch eine Reihe Tumoren zu erwähnen. *Pleuraendotheliome* können in lokalisierten Formen mit Röntgensymptomen auftreten, die denen bei abgekapseltem Exsudat völlig gleichen (Schinz); auch die Rippen können bei diesen Tumoren angegriffen werden, und Pleuraexsudat kann erst spät auftreten. *Expansiv wachsende Pleurasarkome* (Lenk) sollen gewöhnlich nahe dem Zwerchfell vorkommen; sie gehen von dem extrapleuralen Bindegewebe aus und sind gewöhnlich mit einem hämorrhagischen Exsudat kombiniert (Aschoff, Simon). Sie wölben sich indes in der Regel in anderer Weise in die Lunge vor als die extrapleuralen Abszesse. Die Differentialdiagnose zwischen gutartigen Tumoren, wie Dermoiden und Lipomen, und ex[illegible]a-

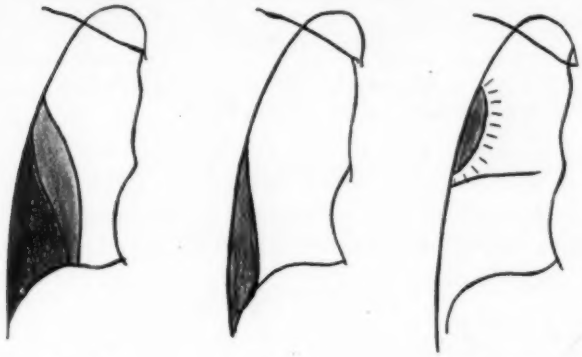

Fig. 9. Fig. 10. Fig. 11.

pleuralen Abszessen dürfte selten Schwierigkeiten bereiten, eher die gegenüber *Hämangiomen in den Rippen*, wenn sie mit Abhebung des Periosts verlaufen (BUCY-CAPP). An extrapleurale Abzesse erinnernde Bilder können auch bei STERNBERGS *Lymphogranulomatose* auftreten, die bei Lokalisation in Knochen (gewöhnlich platten Knochen) eine Abhebung des Periosts durch expansives Wachstum des Tumors herbeiführen kann (FRIEDRICH); man findet dann indes in der Regel gleichzeitig grosse Drüsenpakete.

Lungenaktinomykose beginnt oft subpleural (SCHINZ) und ruft dann eine intensive Schwartenbildung hervor. Es ist denkbar, dass man hier ein Bild wie bei tuberkulösen und septischen extrapleuralen Abszessen bekommen kann.

Eine *Blutung unter der Pleura* folgt in der Regel den Interstitien, kann aber auch grosse Ausbreitung erlangen. Die Blutung wölbt sich dann indes *mehr* gegen die Lunge vor als ein extrapleuraler Abszess. *Paravertebrale Senkungsabszesse* bei tuberkulöser Spondylitis sind am oberen Mediastinum oft einseitig (RACH), was zu diagnostischen Irrtümern Anlass geben kann. Solche Abszesse sehen in frühem Stadium oft wie extrapleurale, subcostale Abszesse aus, aber sie erreichen häufig bedeutende Grösse, wenn sie sich nicht nach aussen entleeren können.

Die *Behandlung* der extrapleuralen Abszesse ist im wesentlichen dieselbe wie bei septischen bzw. tuberkulösen Rippenprozessen im allgemeinen. Im ersteren Fall hat sie also *immer*, im letzteren *in der Regel* operativ zu sein.

ZUSAMMENFASSUNG

Verf. beschreibt 5 Fälle von extrapleuralem Abszess, darunter 4 tuberkulöse und 1 septischer Fall, und erörtert die Differentialdiagnose in solchen Fällen.

SUMMARY

The author describes and discusses the differential diagnosis in 5 cases of extrapleural abscess of which 4 were tuberculous and one septic.

RÉSUMÉ

L'auteur décrit 5 cas d'abcès extra-pleural, dont 4 tuberculeux et 1 septique, et discute ensuite le diagnostic différentiel en de tels cas.

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AUS DER RÖNTGENABTEILUNG DES ZENTRALKRANKENHAUSES IN GEFLE, CHEF: DR. S. ARNELL UND AUS DER RÖNTGENABTEILUNG DER KGL. UNIVERSITÄTSKLINIK IN UPSALA, CHEF: PROF. H. LAURELL

DISSEZIERENDE ANEURYSMEN DER AORTA UND DER ARTERIA ILIACA SOWIE EIN UNGEWÖHNLICHER FALL VON ANEURYSMA SPURIUM[1]

von

Sven Roland Kjellberg

Aneurysmen im abdominalen Teil der Aorta sind verhältnismässig selten. So fand z. B. ESKUCHEN nur 7 Fälle bei 9,500 im Lauf von 12 Jahren gemachten Obduktionen, und SCHRÖTTER 3 Fälle unter 19,500 Obduktionen. Abdominale Aneurysmen sind bedeutend seltener als thorakale, nach Untersuchungen von OSLER ist das Verhältnis zwischen ihnen 1: 10. Sie werden meist bei älteren Menschen über 40 Jahren und häufiger bei Männern als bei Frauen angetroffen. Unter 233 von NIXON gesammelten Fällen befanden sich 207 Männer und 26 Frauen.

Aneurysmale Erweiterungen der Bauchaorta sitzen gewöhnlich im oberen Teil des Abdomen, in der Höhe des Abgangs der A. coeliaca und der Aa. renales. Dies beruht, wie man annimmt, grösstenteils darauf, dass die Aortenwand hier wegen des Abgangs zahlreicher grosser Gefässe am nachgiebigsten ist. Der Aneurysmasack befindet sich meist vorn oder links, weil sich das Aneurysma am leichtesten nach der Richtung entwickeln kann, wo es auf den geringsten Widerstand stösst. Hinten hat nämlich die Aorta eine feste Stütze an der Wirbelsäule, und rechts wird die Aortenwand bis zu gewissem Grade von der Leber gestützt.

Die Symptome variieren nach Angabe der meisten Autoren sehr stark, was hauptsächlich auf verschiedener Grösse und Lage des Aneurysmas beruht. Bisweilen rufen die Aneurysmen keine oder nur unbedeutende Beschwerden hervor, bisweilen dagegen verursachen sie sehr heftige Schmerzen, oft von neuralgischem Charakter, die nach verschiedenen Richtungen ausstrahlen, gewöhnlich nach vorn links sowie nach den Genitalien und den Beinen hinab. Vor allem bei den dissezierenden Aneurysmen pflegen die Schmerzen sehr intensiv zu sein.

[1] Bei der Redaktion am 8. IV. 1938 eingegangen.

Klinisch ist ein pulsierender Tumor im Bauch der wertvollste Befund. Ein zischendes Geräusch kann über dem Aneurysma hörbar sein; Verkleinerung der Amplitude des Kruralpulses sowie Verspätung desselben gegenüber dem Radialispuls sind gleichfalls Zeichen, welche Beachtung verdienen. Vom differentialdiagnostischen Gesichtspunkt ist zu bedenken, dass auch andere intraabdominale Tumoren, die in engem Kontakt mit der Aorta stehen und mit ihr pulsieren, zu Irrtümern Anlass geben können, denn es ist nicht leicht, durch Palpation fortgeleitete und expansive Pulsationen zu unterscheiden. Unter solchen Umständen kann Röntgenuntersuchung oft von grossem Nutzen sein.

Wegen der starken Neigung zu Kalkeinlagerung in der Aorta bei älteren Menschen können diese Aneurysmen vielfach direkt auf dem Röntgenbild wahrgenommen werden, jedoch unter der Voraussetzung, dass sich genügend Kalk in den Wänden befindet. Ist dies nicht der Fall, so kann man nach FARMER u. a. den aneurysmalen Tumor bisweilen dadurch entdecken, dass man benachbarte Teile des Verdauungstraktus mit Luft aufbläst oder ein Pneumoperitoneum anlegt. Wenn das Aneurysma hoch oben im Abdomen sitzt, kann man bisweilen seine Form und seine Pulsationen studieren, indem man den Ventrikel mit Gas oder mit Bariumkontrast füllt. Letzteres wird durch nachstehenden Fall von Aneurysma spurium beleuchtet, wo sowohl der Oesophagus als der Ventrikel beim Photographieren mit Bariumbrei ausgefüllt waren (Fig. 1). Der Fall ist früher von GELLERSTEDT und SÄFWENBERG vor allem vom pathologisch-anatomischen Gesichtspunkt beschrieben worden. Dagegen sind die Röntgenbilder bisher nicht veröffentlicht worden.

Fall I. Am 27. 9. 1932 wurde ein 16-jähriger Knabe wegen heftiger Bauchschmerzen in die Universitätsklinik in Uppsala aufgenommen. Er war 1930 kürzere Zeit wegen Lungentuberkulose behandelt worden. Abgesehen von Kreuzschmerzen während einer kürzeren Periode fühlte sich Pat. danach völlig gesund, bis er am 26. 12. 1931 ganz plötzlich bemerkte, dass das rechte Bein kraftlos war. Er wurde damals in die Medizinische Abteilung aufgenommen und dort unter der Diagnose Poliomyelitis acuta in sanatione + Tub. pulm. dxt. + Vitium organicum cordis behandelt. Nach bedeutender Besserung wurde er aus dem Krankenhaus entlassen und zwecks weiterer Pflege in ein Sanatorium geschickt, wo er einen Monat blieb. Hierauf fühlte er sich bis Anfang September 1932 völlig gesund. Zu dieser Zeit traten ganz plötzlich Schmerzen im Epigastrium, Übelkeit und Brechreiz auf. Die Schmerzen strahlten in die linke Schultergegend aus. Nach ein paar Tagen verschwanden die Beschwerden, kamen aber dann mehrfach wieder und waren jedesmal stärker. Den letzten solchen Anfall, der schlimmer als jemals vorher war, hatte er am 8. 10. Die Schmerzen waren so stark, dass er nicht ruhig liegen konnte. An demselben Tage wurde er in die Chirurgische Abteilung der Universitätsklinik aufgenommen. Im letzten Monat hatte er ausserdem gewisse Schluckbeschwerden gehabt; es war ihm, als sitze ein Hindernis in der Höhe des unteren Sternumteils.

Der Status bot abgesehen von heftigen Schmerzen und Druckempfindlichkeit im Epigastrium nichts von besonderem Interesse. . .

Fig. 1.

Fig. 2.

Röntgen 30. 9. (Fig. 1 und 2): Der Oesophagus zeigt in seinem unteren Teil ein Passagehindernis. Er ist hier nach vorn rechts verschoben und durch ein tumorartiges, rundliches, apfelsinengrosses, teilweise hinter der linken Herzhälfte liegendes Gebilde verengt. Die linke Zwerchfellkuppe steht hoch und schleppt beim Atmen etwas nach. Kein Pleuraexsudat. Der Tumor sitzt neben der Wirbelsäule und besteht teils aus einer kleineren, oberhalb des Zwerchfells liegenden Partie, teils aus einer bedeutend grösseren, mit dem Leberschatten verschmelzenden Tumormasse, welche sowohl den Oesophagus als den Ventrikel nach vorn rechts verschiebt. Keine Pulsationen sichtbar. Diagnose unsicher. Tumor?

Probelaparotomie 10. 10.: Es zeigte sich, dass der oben beschriebene Tumor retroperitoneal lag und eine schmierige, graurote, mit Gerinnseln vermischte Masse enthielt. Aus diesem Grunde entstand starker Verdacht auf Sarkom. Pulsationen waren nicht zu fühlen. Bei Herausschaffung der schmierigen Masse trat ganz plötzlich eine sehr starke Blutung ein, und einige Stunden später starb Pat.

Obduktion: Unmittelbar oberhalb der Abgangsstelle der linken Nierenarterie sieht man einen retroperitonealen Tumor von doppelter Faustgrösse, parallel zur Aorta, links

von der Wirbelsäule. Der Tumor verschiebt den Magen nach vorn und setzt sich mit einer bruchartigen Ausstülpung des hinteren Teiles der Zwerchfellkuppe in die linke Pleurahöhle fort, während er die Speiseröhre nach vorn rechts verschiebt. Der Tumor erwies sich als ein Aneurysma spurium, das hauptsächlich para-aortal in dem retroperitonealen Bindegewebe lag. Das Aneurysma war dadurch entstanden, dass der obere Teil der Bauchaorta von käsigen, paravertebral gelegenen, tuberkulösen Lymphdrüsen arrodiert worden war. Ausserdem ergab sich, dass die Wirbelkörper von L IV und L V käsig eingeschmolzen waren. Von dieser Gegend nach dem Lig. inguinale hinab erstreckte sich auf beiden Seiten hinter dem M. psoas ein typischer Senkungsabszess.

Die richtige Diagnose zu stellen, war in diesem Falle nicht leicht. Der auf dem Röntgenbild sichtbare, an der Wirbelsäule gelegene grosse Tumor sowie die starken, ausstrahlenden Schmerzen sprachen in gewissem Grade für ein Aneurysma. Das Röntgenbild hatte jedoch ein von gewöhnlichen Bauchaneurysmen abweichendes Aussehen, insofern der Bauchtumor sich in die linke Thoraxhälfte hinein fortsetzte und das Zwerchfell gleichsam vor sich her schob. Ausserdem waren keine Pulsationen des Tumors sichtbar. Deshalb vermutete man einen Tumor anderer Art, und zwar in erster Linie ein Sarkom. Dass die tuberkulösen Veränderungen im unteren Teil der Lumbalwirbelsäule zu dem früheren Symptombild beigetragen haben, steht ausser Zweifel, aber im Hinblick auf das pathologisch-anatomische Bild und die starken Beschwerden, die bei dissezierenden Aneurysmen vorkommen, ist mit Sicherheit anzunehmen, dass die heftigen Schmerzanfälle, die Pat. im letzten Monate vor seinem Tode hatte, durch wiederholte Blutungen in das Retroperitoneum verursacht waren, wo allmählich eine grosse Bluthöhle entstand, die mit flüssigem Blut und Blutkuchen verschiedenen Alters gefüllt war.

Die Sektion gab die Erklärung für den gegen die linke Lunge vorgewölbten, rundlichen Tumor. Es handelte sich um eine äusserst seltene Komplikation bei einem retroperitonealen Aneurysma spurium: eine bruchartige, blutgefüllte Ausstülpung des hinteren Zwerchfellteils.

Oft ist die aneurysmale Erweiterung auf der Röntgenplatte nicht wahrnehmbar, und unter solchen Umständen können gewisse indirekte Zeichen von grossem Nutzen sein. Infolge des expansiven Wachstums rufen nämlich Aortenaneurysmen häufig ziemlich scharf konturierte Druckusuren an den Wirbelköpern hervor, während die Zwischenwirbelscheiben unbeschädigt bleiben. Dieses Bild ist ziemlich typisch für Aneurysma.

Infolge der grossen Veränderungen und der Sprödigkeit der Aneurysmawände kommt es oft vor, dass sie platzen. Entweder zerreist nur

die Intima, und das Blut wird dann zwischen die Intima und die Media gepresst; oder es zerreisst auch die Media teilweise, und das Blut dringt zwischen die Mediaschichten ein, sog. dissezierendes Aneurysma. Oft zerreist die Aortenwand ganz, und das Blut wird dann in der Regel in das retroperitoneale Gewebe gedrückt. Auch bei den dissezierenden Aneurysmen findet gewöhnlich allmählich eine vollständige Durchbrechung der Gefässwand mit demselben Endergebnis statt, wie wenn die ganze Gefässwand direkt zerreisst. Jedoch kommt es bisweilen vor, dass das Blut nach Ruptur der Intima diese eine kürzere oder längere Strecke unterminiert, um dann durch eine neue Intimaruptur in das Aortenlumen zurückzukehren. Wenn ein Aneurysma vollständig rupturiert, tritt meist eine starke retroperitoneale Blutung ein. Gelegentlich kann das Aneurysma jedoch nach einer anderen Richtung durchbrechen. So haben z. B. MARLOW und DOUBLER zwei Fälle beschrieben, wo das Aneurysma in das Duodenum durchgebrochen war, ZYPKIN einen Fall mit Durchbruch in den Ventrikel, und OMODEI-ZORINI einen, wo das Peritoneum gerissen war und das Blut grösstenteils frei in der Bauchhöle lag.

Da dissezierende Aneurysmen im abdominalen Teil der Aorta und in den AA. iliacae zu den Seltenheiten gehören, interessiert vielleicht der Bericht über drei Fälle, die in den Jahren 1935, 1936 und 1938 auf der Röntgenabteilung des Krankenhauses in Gefle zur Untersuchung gekommen sind. Von besonderem Interesse in diesen drei Fällen ist der Umstand, dass man mit Hilfe von Röntgen zu einer Wahrscheinlichkeitsdiagnose gelangte. Alle drei Fälle wurden wegen heftiger Bauchschmerzen nach der Röntgenabteilung überwiesen, der erste unter Ileusverdacht, die anderen als unklare Bauchfälle.

Fall II. Waldarbeiter A. E., 75 Jahre. Pat. war am 14. 3. 1935 rasch mit starken Bauchschmerzen und Erbrechen erkrankt. Genauere Auskünfte waren nicht zu erhalten, weil er sehr schwerhörig und sein Allgemeinzustand stark beeinträchtigt war.

Aus dem Status: Pat. ist stark mitgenommen, hat schwachen, frequenten Puls und ist hin und wieder fast bewusstlos. Cor: Bedeutende Arhythmie mit Pulsdefizit. Töne dumpf. Pulm.: Nichts von Interesse.

Bauch unbedeutend aufgetrieben. Rechts im Bauch wird ungefähr in Nabelhöhe und unmittelbar darunter ein reichlich faustgrosser, ziemlich fester Tumor getastet, möglicherweise auch ein kleiner Tumor rechts in der Fossa iliaca. Per rectum: Nichts von Interesse.

Röntgen (Fig. 3): Unmittelbar links von L. III—L. IV sieht man eine grössere Anzahl Kalkschollen, die bis zu ein paar cm lang sind und teilweise eine nach links konvexe Bogenlinie bilden. Dicht unterhalb dieser Schollen befindet sich ein fast hühnereigrosser, rundlicher, dichterer Schatten mit reichlichen Kalkeinlagerungen. Da diese Gebilde ganz dicht an und unmittelbar vor der Wirbelsäule liegen, ge-

hören sie höchstwahrscheinlich zur Aorta, die solchenfalls aneurysmatisch erweitert ist. Auf dem Übersichtsbild des Bauches erblickt man ausserdem rechts einen diffusen, dichteren Schatten. Die rechte Niere und die rechte Psoaskontur lassen sich aus diesem Schatten nicht ausdifferenzieren. Dagegen lässt sich die linke Psoaskontur deutlich abgrenzen, speziell in ihrem unteren Teil. Diese Symptome sprechen für eine auf der rechten Seite befindliche, retroperitoneale Affektion, welche sowohl die Niere als den M. psoas betrifft. Ein entzündlicher Prozess liegt wahrscheinlich nicht vor, da beide Zwerchfellkuppen frei beweglich sind und eine Infiltration der Weichteile in den Flanken nicht zu bemerken ist. Deswegen ist eine retroperitoneale Blutung, ausgegangen von dem oben erwähnten Aneurysma, zu vermuten. Röntgenologische Zeichen von Ileus oder Hindernis im Kolon bestehen nicht.

Während der nächsten Stunden nach der Untersuchung war der Zustand sehr schlecht, und nach einigen Stunden trat ganz plötzlich der Tod ein.

Aus dem Obduktionsprotokoll: Bauch: Sämtliche Organe im Bauch ziemlich blass. Retroperitoneal sieht man eine reichlich mannskopfgrosse Ansammlung von grösstenteils koaguliertem Blut; die Bluthöhle erstreckt sich von der rechten Nebenniere nach dem kleinen Becken hinab und reicht an der Aortenteilung über die Mittellinie. An der Wirbelsäule und nach dem kleinen Becken hinunter sind die Gerinnselmassen teilweise organisiert. Die rechte Niere ist ganz in die Blutmasse eingebettet. An der Teilung der Aorta in die Aa. iliacae erblickt man ein apfelsinengrosses Aneurysma mit ca. 1 cm dicker, stark kalkinkrustierter Wand. Im rechten unteren Teil des Aneurysmas bemerkt man eine ungefähr 1 cm lange Ruptur, welche die retroperitoneale Blutung hervorgerufen hat. Die Aorta und die Aa. iliacae sind stark verkalkt. Nieren, Ureteren und Blase zeigen normales Aussehen.

P. A. D.: Arteriosklerotische, atheromatöse und stark petrifizierte Aorta mit älterer thrombotischer Auflagerung auf der Intima sowie Durchbrechung derselben und unregelmässige Aufspaltung der ganzen Gefässwand; extravaskuläres Hämatom in umgebendem Fettgewebe.

Fall III. Frau H. E., 55 Jahre. Seit mehreren Jahren hatte die Patientin ab und zu Schmerzanfälle wie bei Gallenstein gehabt, war jedoch niemals gelb gewesen. Die Beschwerden waren immer sehr schnell vorübergegangen. Am 9. 8. 1936 hatte sie abermals einen solchen Anfall mit Schmerzen rechts im Epigastrium. Die Schmerzen strahlten in den Rücken aus, verschwanden aber im Laufe des Tages völlig. Seitdem gänzlich beschwerdenfrei bis zum 11.8., als sie erneut mit heftigen Schmerzen erkrankte, die jedoch diesmal links in der Fossa iliaca und in der linken Flanke sassen. Ausserdem hatten sie einen anderen Charakter als bei den früheren Anfällen. Kein Erbrechen, spontaner Stuhlgang und reichlicher Abgang von Gasen. Am folgenden Tag trat plötzlich eine starke Verschlechterung des Zustandes ein, weshalb Pat. an das Zentralkrankenhaus in Gefle überwiesen wurde.

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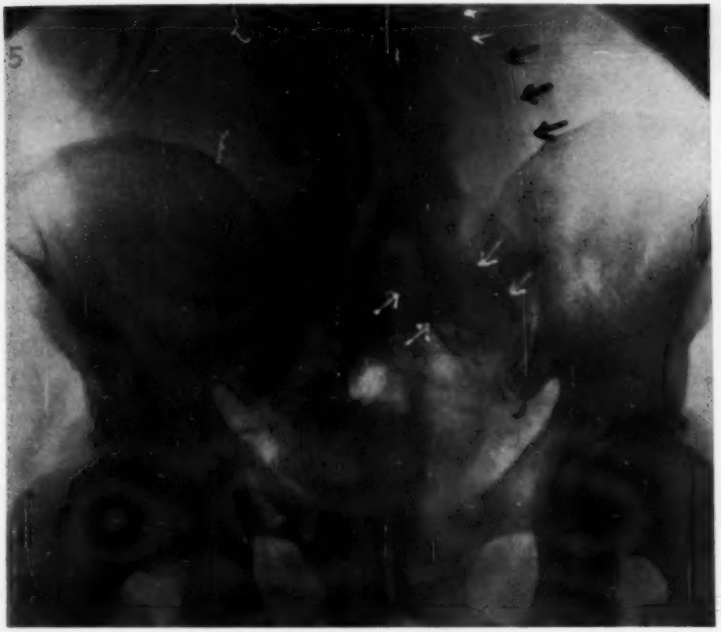

Fig. 3. Rechts von der Lumbalwirbelsäule ist ein diffuser Schatten sichtbar. Die schwarzen Pfeile bezeichnen die Psoaskontur auf der linken Seite, die weissen geben Verkalkungen teils im Aneurysma, teils in der Bauchaorta an.

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Röntgen[1] (Fig. 4—6,): Auf dem Übersichtsbild sieht man einen mässig ausgesprochenen Kolometeorismus. Unmittelbar links von der Mittelinie erblickt man einen ziemlich grossen, teilweise kalkdichten Schatten, der in der Höhe von L I—L IV liegt und nach links teilweise von einer bogenförmigen Kalkinkrustierung begrenzt ist. Dieser Schatten liegt teilweise auf der Wirbelsäule, teilweise links von ihr. Auf dem Seitenbild zeichnet er sich unmittelbar vor der Wirbelsäule ab und beruht wahrscheinlich auf einer aneurysmatisch erweiterten Aorta. Im mittleren Teil des Bauchfildes sieht man links einen bedeutend grösseren Schatten, in dem die linke Psoaskontur nicht mit Sicherheit unterschieden werden kann. Ebensowenig kann man aus ihm den unteren

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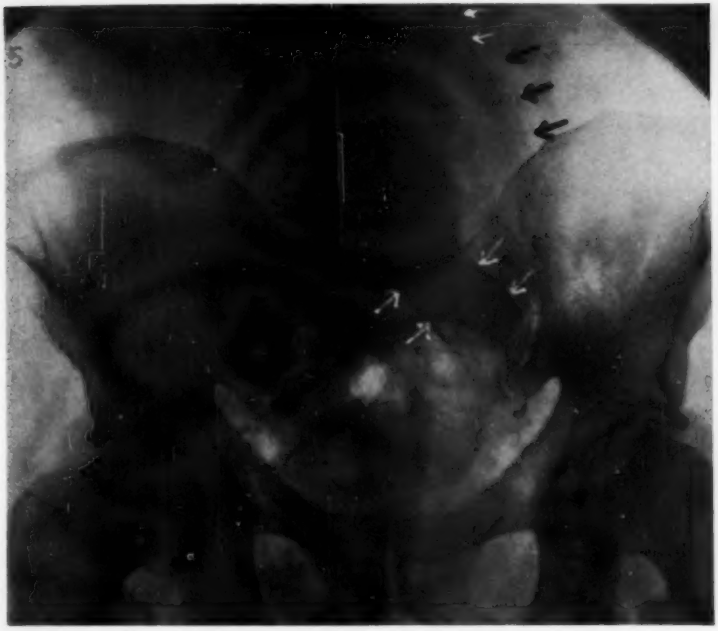

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Fig. 4.

Fig. 5.

Auf Figg. 4 und 5 ist eine diffuse Verschleierung über dem linken Bauchfeld sichtbar. Die weissen Pfeile bezeichnen die Begrenzung des Aneurysmas, die schwarzen die Psoaskontur auf der rechten Seite.

Fig. 6. Seitenbild. Die weissen Pfeile bezeichnen die Begrenzung des Aneurysmas.

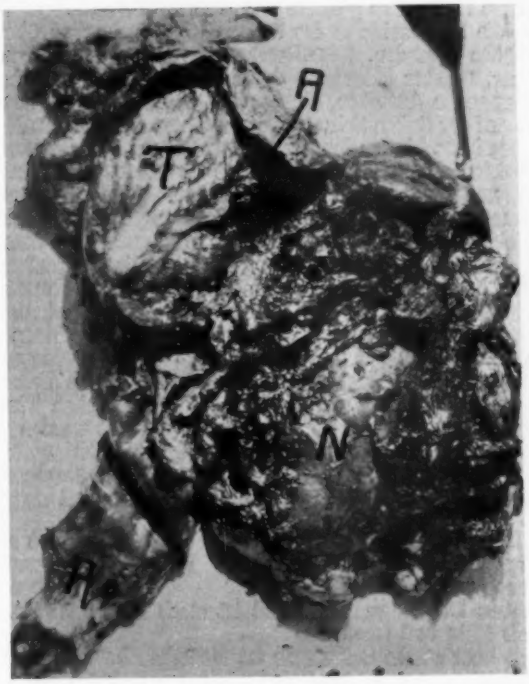

Fig. 7. Die aufgeschnittene Aorta mit Aneurysmasack sowie das grosse retroperitoneale Hämatom.

A = Aneurysma. Ao = Aorta, T = Thrombus, N = Niere. um die man die grossen Gerinnselmtssen sicht.

Teil der linken Niere ausdifferenzieren, nur die obere laterale Kontur tritt schwach hervor. Leichte rechtskonvexe Skoliose. Beide Zwerchfellkuppen sind frei beweglich und zeigen auf beiden Seiten dasselbe Aussehen. Die Symptome sprechen für eine retroperitoneale Affektion auf der linken Seite, die jedoch keinen entzündlichen Charakter hat. Die aneurysmatische Erweiterung der Aorta abdominalis lässt also ein geplatztes Aneurysma mit retroperitonealer Blutung vermuten.

Der Zustand der Patientin war in den nächsten Tagen ziemlich unverändert. Am 13. 8. trat indes ein neuer Anfall mit fadenfeinem Puls und Bewusstlosigkeit ein. Nach Stimulanz war eine gewisse Besserung zu bemerken. Der Zustand war während der folgenden Tage ziemlich unverändert, hin und wieder bewusstlos. Am 17. 8. Mors subita.

Obduktion: Die Aorta ist in ihrer ganzen Länge deutlich verbreitert; die Aorta thoracalis hat eine gänzlich unversehrte Intima bis zum Abgang der grossen Halsgefässe.

Von hier nach unten findet man grössere und kleinere Kalkschollen. Bei Eröffnung des Bauches quellen die Eingeweide in der linken Hälfte bedeutend über das Niveau der in der rechten Hälfte liegenden. Die Ursache hiervon ist ein ungeheuer grosser, retroperitonealer Tumor, welcher bläuchlich durchschimmert. Die sichtbaren Baucheingeweide sind von normalem Aussehen, aber auffallend blass und blutarm. Die retroperitoneale Resistenz auf der linken Seite besteht in einem sehr grossen Hämatom, das sich von der Linea innominata bis zur Zwerchfellkuppe hinauf erstreckt und diese nach oben schiebt, so dass sie eine Handbreit höher steht als die rechte. Mitten in diesem Hämatom liegt die normalgrosse linke Niere. Aorta, Vena cava, linke Niere und Hämatom wurden in einem Zusammenhang herausgenommen. Es zeigte sich nun, dass die Aorta unmittelbar oberhalb ihrer Teilung in die Aa. iliacae communes eine über faustgrosse Ausbuchtung hatte, die sich fast bis zum Abgang der A. coeliaca hinauferstreckte. Auf der linken Seite dieser Ausbuchtung befand sich eine 10 cm lange Ruptur, aus der Koagel herausragten. Die Aorta wurde aufgeschnitten, und dicht unterhalb des Abgangs der A. coeliaca wurden in dem Aneurysma reichliche Kalkinkrustationen angetroffen (entsprechend den Kalkeinlagerungen, die man auf der Röntgenplatte gesehen hatte). Der Inhalt der aneurysmalen Ausbuchtung bestand zum grössten Teil aus einer nahezu faustgrossen, teilweise wandfesten, gräulichen, säh elastischen Thrombenmasse, die durch die Ruptur teilweise von ihrem Wandansatz getrennt worden war. Ausser dem Thrombus fanden sich Massen von grösseren und kleineren Gerinnseln (Fig. 7).

P. A. D. Die Aortenwand ist durch arteriosklerotische Degenerations- und Verkalkungsherde schwer destruiert. Die elastischen Lamellen sind »zerzaust» und defekt.

Fall IV. R. P., 46-jähriger Mann. Erkrankte ganz plötzlich am 14. 3. 1938 mit sehr heftigen Schmerzen im linken Unterbauch. Wurde ca. 4 Stunden später in das Zentralkrankenhaus in Gefle aufgenommen.

Aus dem Status: Der Allgemeinzustand ist stark beeinträchtigt. Pat. sieht ausgeblutet aus. Puls klein und frequent.

Bauch: Klagt über starke Schmerzen im Unterbauch. Intensive Empfindlichkeit in der linken Fossa iliaca, wo eine gewisse Ausfüllung palpiert wird. Deutliche Muskelverteidigung.

Röntgen: Auf dem Übersichtsbilde des Bauches sieht man im ganzen linken Teil einen dichten Schatten. Nieren- und Psoaskonturen können auf der linken Seite nicht ausdifferenziert werden, dagegen treten sie auf der rechten sehr deutlich hervor. Unbedeutende Gasmenge im Kolon und in den Dünndärmen. Keine Niveaus sichtbar. Im übrigen zeigt das Übersichtsbild normales Aussehen. Das Bild spricht in erster Linie für eine grosse retroperitoneale Blutung auf der linken Seite. Eine kleinere Flüssigkeitsmenge intraperitoneal ist nicht ausgeschlossen. Ein verkalktes Aneurysma ist nicht zu bemerken.

Pat. wurde in unmittelbarem Anschluss an die Röntgenuntersuchung operiert. Dabei wurde auf der linken Seite eine grosse retroperitoneale Blutung angetroffen, die sich von der Fossa iliaca bis hinauf zum oberen Nierenpol erstreckte. Ungefähr 2 cm unterhalb der Teilung in die Aa. iliacae communes fand man an der A. iliaca sin. ein doppelt walnussgrosses, rupturiertes Aneurysma.

Der Zustand des Patienten war die ganze Zeit über stark beeinträchtigt, und ca. 4 Stunden nach der Aufnahme ins Krankenhaus trat der Tod ein.

P. A. D. Leber, Milz und Nieren zeigen nichts Bemerkenswertes. Ein Schnitt von der Aorta thoracica lässt ziemlich leichte arteriosklerotische Veränderungen der Intima

erkennen, während die Media auch in elastingefärbten Präparaten normale Verhältnisse aufweist. Ein Schnitt von der Arteria iliaca in der Nähe des Aneurysmas zeigt starke arteriosklerotische Veränderungen der Intima sowie ausgedehnte Zerstörung auch der Media. Ca. 4 cm lange Wandruptur im lateralen, oberen Teil des Aneurysmas.

Wie oben bemerkt, konnte in zwei dieser Fälle die aneurysmatische Erweiterung der Aorta röntgenologisch durch das Vorhandensein von Kalkeinlagerungen in der Gefässwand nachgewiesen werden. Die Dissektion und die Ruptur des Aneurysmas aber gaben sich durch eine grosse, in der Hauptsache einseitige retroperitoneale Blutung zu erkennen. Die Röntgensymptome bei einer solchen Blutung, wenn sie auch die Nierenloge in Mitleidenschaft zieht, gleichen denen, die LAURELL bei Paranephritis (1921) sowie bei retroperitonealen Blutungen um die Niere (1930) beschrieben hat. Aus seiner Abteilung sind gleichartige Symptome von HULTÉN auch bei Nebennierenblutung (1928) geschildert worden.

Diese Symptome sind vor allem ein diffuser, der Blutung entsprechender Schatten, Undeutlichkeit oder Verschwinden der Nieren- und Psoaskontur auf der kranken Seite sowie Lumbalskoliose, die nach der kranken Seite konkav ist.

ZUSAMMENFASSUNG

Verf. beschreibt zwei Fälle von rupturierten Aortenaneurysmen, welche mit Hilfe von Röntgen festgestellt wurden, ausserdem einen Fall von rupturiertem Aneurysma in der Arteria iliaca. In allen drei Fällen war auf der einen Seite eine retroperitoneale Blutung eingetreten, die auf der Röntgenplatte eine Auslöschung sowohl der Psoas- als der Nierenkontur daselbst hervorrief. Ausserdem wird ein Aneurysma spurium geschildert, das retroperitoneal am oberen Teil der Bauchaorta lag und infolge einer rundlichen, bruchartigen Ausstülpung des hinteren Zwerchfellteiles in die linke Thoraxhälfte hinein den falschen Verdacht auf Tumor weckte.

SUMMARY

The author describes two cases of ruptured aortic aneurysm which were diagnosed with the help of roentgen examination. He also reports one case of rupture of the iliac artery. In all three cases there had been retroperitoneal hemorrhage which had defaced both the psoas and renal contours on the roentgen plate. The author also reports an aneurysma spurium situated retroperitoneally close to the upper part of the abdominal aorta. Tumour was suspected because of a roundish, hernia-like protrusion of the posterior portion of the diaphragma into the left thoracic cavity.

RÉSUMÉ

L'auteur décrit deux cas de rupture d'anévrisme dans l'aorte, diagnostiqués à l'aide des rayons roentgen. Il décrit en outre un cas de rupture d'anévrisme dans l'artère ilia-

que. Dans chacun de ces trois cas, une hémorragie rétro-péritonéale survint qui, sur le cliché roentgen, produisit un effacement des contours du psoas et des reins. L'auteur décrit finalement un aneurysma spurium, rétro-péritonéalement situé près de la partie supérieure de l'aorte abdominale, et qui en raison d'une saillie, arrondie et ressemblant à une hernie, de la partie postérieure du diaphragme dans la moitié gauche du thorax, fit soupçonner une tumeur.

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FROM THE ROENTGEN DEPARTMENT ST. GÖRANS SJUKHUS, STOCKHOLM.
CHIEF: NILS WESTERMARK, M. D.

ON BRONCHOSTENOSIS, A ROENTGENOLOGICAL STUDY[1]

by

Nils Westermark

Introduction

Bronchostenosis is a very common phenomenon in different kinds of lung disease. All according to its extent and distribution bronchostenosis gives rise to radiological changes of various appearance which may entirely dominate the whole picture. In order to be able correctly to interpret the radiological appearance of the lungs, it is necessary, therefore, to have a thorough knowledge of such changes.

It is a well known fact that incomplete bronchial occlusion leads to emphysema and that complete occlusion gives rise to atelectasis of the supplied lung area. It is also common knowledge that emphysema and atelectasis cause, respectively, expansion and retraction of the thorax, depression and elevation of the diaphragm and, finally, displacement of the mediastinum from and towards the affected side. Respiratory oscillation of heart and mediastinum, a characteristic sign of bronchostenosis, was first described by HOLZKNECHT.

Yet, insufficient attention has been paid to the roentgenology of bronchostenosis of various degree and distribution, above all in regard to appearance, form and localisation, as also in regard to occurrence in different kinds of lung disease. Nor has due regard been made to their importance for a correct interpretation of the radiogram and to the possible complications that may be produced by bronchostenosis.

Anatomy and roentgen anatomy of the bronchi

For the roentgen diagnostics of bronchostenosis it is essential to have a complete knowledge of the anatomy of the bronchi and of the distri-

[1] Read at the 8th Meeting of the Northern Ass. for Medical Radiology June, 1936. Submitted for publication June 7, 1938.

bution and topography of the pulmonary areas corresponding to the different bronchi. For a closer study of these parts the reader is referred to the well known and excellent papers on the anatomy of the lungs by HASSE and FELIX. For a study also of the roentgen anatomy of the bronchi I injected into the trachea of patients, recently dead, lipiodol and filled up the bronchial tree with this opaque fluid. On subsequent radiograms in different directions very good pictures were obtained of the bronchial tree and of the distribution of the different bronchi. In some of these cases anatomical casts of the bronchial tree were also made. By such means a very useful comparative study could be made of the radiograms and these anatomical casts. Furthermore my study of the roentgen anatomy of the bronchi has been based upon 200 actual cases on which bronchographical examination was carried out during life.

My own investigations have in the main confirmed the results obtained by HASSE and FELIX. In what follows I shall therefore make use of HASSE's nomenclature.

Just before crossing the pulmonary artery the *right main bronchus* (Fig. 1) gives off a large side branch which supplies the upper lobe. This side branch is called bronchus eparterialis and soon divides into three branches, one ventral, one dorsal and one apical branch which supply corresponding wedge-shaped areas of the upper lobe. The areas of distribution of these bronchial branches are most clearly in evidence on a lateral picture (compare fig. 3 and 5), since the dorsal and ventral branches pass into the lungs somewhat obliquely backward-outward and forward-outward respectively. In an antero-posterior picture we find that the areas of distribution of the different bronchi fairly largely cover one another wherefore it is impossible here to study the bronchial distribution. The distributive area of the apical branch is however mainly made up of the apical field in addition to the medial parts of I. 1 and I. 2 by ordinary technique. On an antero-posterior picture its lower lateral part is covered by the distributive area of the posterior branch while its central area is covered by the distributive area of the anterior branch. The distributive area of the anterior branch is localised in an antero-posterior picture to the medial lower part of the upper lobe and the posterior branch to the lateral part of the same lobe.

That portion of the right main bronchus which continues after giving off bronchus eparterialis crosses the pulmonary artery and is called bronchus hyparterialis. This branch subsequently divides into 4 pairs of lateral branches passing, two and two, into a dorsal and a ventral direction. These branches, however, like the dorsal and ventral branches of the bronchus eparterialis pass into the lung somewhat obliquely backward-outward and forward-outward respectively. The fir

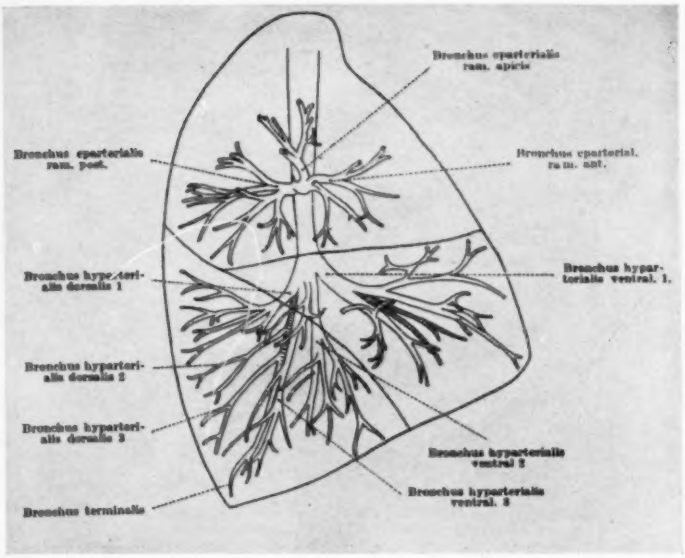


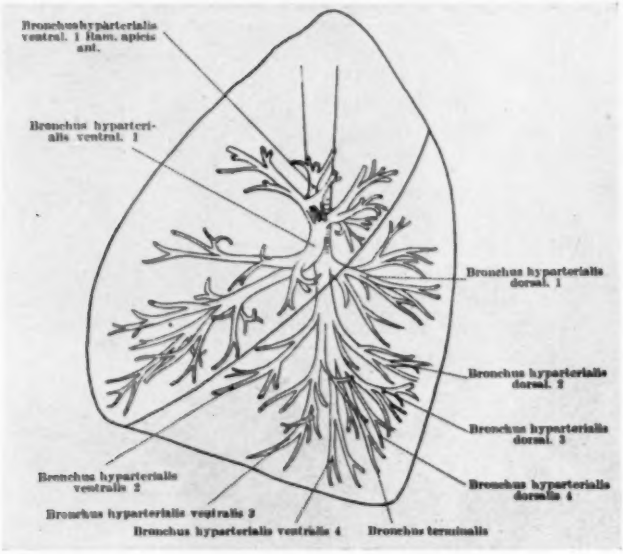
Fig. 1. Bronchial tree of right lung seen from the side (after HASSE).

ventral branch supplies the middle lobe and the remaining branches the lower lobe.

The bronchus of the midlobe, or the first ventral lateral branch of the bronchus hyparterialis, divides into an anterior, superior and a lateral inferior branch. The anterior superior branch supplies the upper medial portion of the middle lobe and the lateral inferior branch the lateral lower portion of the same lobe.

The branches from the bronchus hyparterialis which supply the lower lobe are located in different planes above one another in a dorsal and ventral direction and supply wedge-shaped areas of the lung with the wedges lying above each other and directed dorsally and ventrally respectively. They also appear best, separately, in a lateral picture but also fairly well in semi-oblique projections. In antero-posterior projections the ventral branches are largely covered by the midlobe and the upper dorsal branches by the upper lobe while the lower dorsal branches are mainly projected within the lateral basal portion of the lung field.

These branches, just mentioned, and given off from bronchus eparterialis and hyparterialis are still further divided into bronchial branches of the second to the sixth degree inclusive. These branches pass into different directions and supply smaller wedge-shaped areas within


Bronchushyparterialis ventral. 1 Ram. apicis ant.
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Bronchus hyparterialis dorsalis 4
Bronchus hyparterialis ventralis 2
Bronchus hyparterialis ventralis 3
Bronchus hyparterialis ventralis 4
Bronchus terminalis

Fig. 2. Bronchial tree of left lung seen from the side (after HASSE).

distributive areas of respective lateral branches. A study of these branches on the radiogram requires a special technique of adjustment specific for each individual branch and only obtainable under screening control.

The left main bronchus (Fig. 2) crosses the pulmonary artery before giving off any lateral branches. The main bronchus which after the crossing is given the name of b r o n c h u s h y p e r t e r i a l i s s i n. then divides into 4 pairs of lateral branches giving off in pairs into a dorsal and a ventral direction. The areas of distribution of these bronchial branches are best seen in a lateral picture (comp. fig. 4 and 6).

The first ventral branch supplies the upper lobe and the others the lower lobe. The branch of the upper lobe soon divides into an upper and a lower anterior branch. The upper branch in its turn divides, like bronchus eparterialis, into one ventral, one dorsal and one apical branch which supply ventral, dorsal and apical wedge-shaped areas respectively of the upper portion of the upper lobe. The lower anterior branch divides before long, like bronchus hyparterialis I dx., into an anterior and a lateral branch. These branches supply, respectively, an anterior and a lateral wedge of the lower anterior portion of the upper lobe. The distributive areas of the three side branches of the upper branch appear

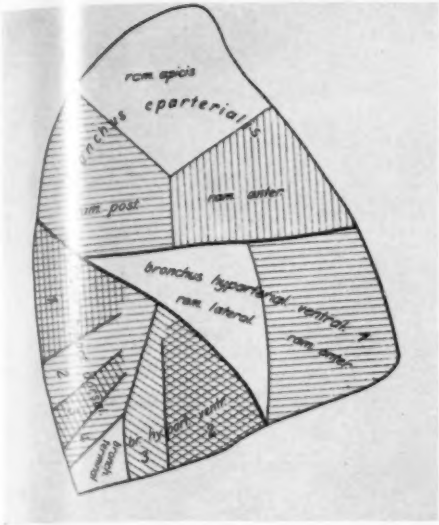


Fig. 3. Distributive areas of different bronchial branches of right lung seen from the side (after HASSE).

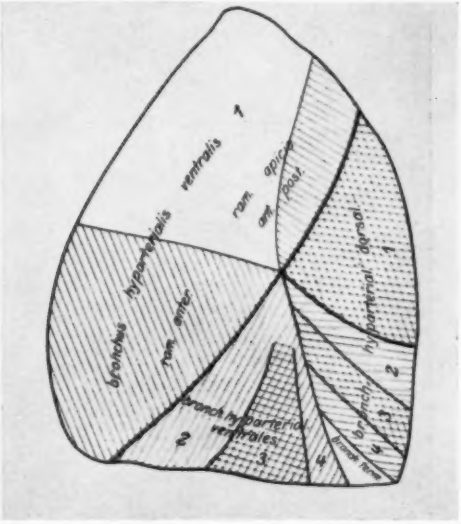


Fig. 4. Distributive areas of different bronchial branches of left lung seen from the side (after HASSE).

on the radiogram mainly as those of the bronchus eparterialis and those of the lower branches of the lower bronchus as also those of the bronchus hyparterialis I dx.

Those branches supplying the lower lobe mainly divide as the bronchi of the right lower lobe and their areas of distribution appear as on the right side.

The further bronchial division also takes place as on the right side.

Technique of examination

To enable a roentgen diagnosis to be made of a bronchostenosis it is necessary not only to make a careful screening examination of the patient, but also to take pictures of the lungs in different directions and perhaps also under different phases of respiration. It is necessary therefore in each case to take not only antero-posterior pictures but also a lateral picture with the deseased lung next to the film. It is also very useful to take pictures in a direction from behind medially, from the side forwards, from behind laterally and medially-forwards besides other directions that may prove suitable.

Fig. 5. Distributive areas of different bronchial branches of right lung traced on lateral radiogram of same lung. Diagrammatic drawing after studying lipiodol injections into bronchi and localisation of atelectasis.

Fig. 6. Distributive areas of different bronchial branches of left lung traced on lateral radiogram of same lung. Diagrammatic drawing after studying lipiodol injections into bronchi and localisation of atelectasis.

Pictures taken in directions as indicated above yield far more than stereoscopic pictures in an antero-posterior direction and even more than tomography.

By using the above mentioned technique one is generally able to detect a bronchostenosis on roentgen examination. In the majority of cases, however, one is unable directly to discover the cause of the stenosis. To this end bronchography is necessary. Before this is carried out, however, one should carefully have localised the stenosis by preliminary roentgen examination. A very small amount of opaque substance is then sufficient since it is only necessary to fill up those bronchial branches that lead to the affected area. Any possible harmful effects of the injected fluid can thereby be reduced to a minimum; also is less fluid left behind in the parenchyma than if larger quantities be employed.

There is also another great advantage associated with a small amount of oil, in that better pictures are generally obtained of the bronchial relief if the contrast agent is allowed only to line the walls than if it completely fills up the bronchi.

The best opaque agent is iodised oil, lipiodol or iodipin. Prior to the injection the lipiodol should be warmed to a little above body temperature. This makes it more fluid and causes it to spread about more readily in the bronchi besides producing no irritation. Thereby the oil can also more readily be distributed and be made to flow to the intended bronchus by shifting the position of the patient.

With the view to preventing irritable coughing during the injection and examination, it is advisable to anaesthetise the pharynx and larynx with 2 % pantocain solution before the injection. This injection should be carried out in immediate connection with the roentgen examination so as to enable the lipiodol, by appropriate shifting of the patient, to become distributed to the intended place without necessarily having to fill up surrounding adjacent normal bronchi to excess.

At St. Göran Hospital we have in most cases needed no more than 2—5 cc. lipiodol for bronchography. It is only in exceptional cases that larger quantities have been employed. The technique of injection is very simple. A bent canula is introduced via the mouth into the larynx or hypopharynx immediately above the larynx. The lipiodol is then injected quickest possible under deep breathing on the part of the patient. During the injection the patient is put in such a position, or his position is shifted in such a way that the lipiodol is made to flow into that or those bronchi to be examined. Immediately afterwards screening is undertaken under continued shifting of the patient's position until the lipiodol has reached the intended bronchus. Exposures are then made in different positions and in different directions. All positions are checked by screening. After the examination the patient is placed in suitable positions to enable the lipiodol most readily to pass up into the main bronchus and be got rid of by coughing. By using the above technique we have only in exceptional cases experienced any greater retention in the parenchyma. Most patients are able almost completely to empty their bronchi.

The roentgenology of bronchostenosis

From a radiological viewpoint bronchostenosis can be divided into 3 different stages all according to the degree of stenosis.

Stage 1. In the case of slight stenosis which permits the air to pass through during inspiration as well as expiration we shall find that that part of the lung located on the peripheral side of the stenosis will not

be filled with air during inspiration to the same extent as the surrounding lung tissue. There will thus be a diminished air-entry during inspiration into the part of the lung corresponding to the area of distribution of the constricted bronchus wherefore the alveoli here will become less expanded than the rest. The intra-alveolar pressure will thus also become reduced (LAURELL). This diminished pressure will produce a suction action on the blood-vessels causing the capillaries within this region to be filled with blood. This moderate atelectasis in addition to the increased amount of blood will cause the lung area corresponding to the constricted bronchus to become denser. The lung area in question will become typically wedge-shaped in analogy with the anatomy of the bronchi as above described. The wedge will be directed with its apex towards the hilum and its base either forwards or backwards within the lung, depending upon whether a ventral or a dorsal bronchial branch has become the seat of stenosis. Surrounding lung tissue shows no changes. The above mentioned altered alveolar pressure in the distributive area of the stenotic bronchus may also give rise to displacement of heart and mediastinum towards the affected side. Since this displacement is more marked during inspiration than expiration we get the phenomenon of respiratory oscillation. On the same cause the diaphragm becomes somewhat elevated and exhibits diminished respiratory movements. The thoracic wall is somewhat retracted corresponding to the distributive area of the constricted bronchus. This early stage of stenosis is very readily overlooked. In order not to miss it it is necessary to make a very careful screening examination and preferably take some pictures during inspiration as well as expiration.

Fig. 32 illustrates an instance of Stage I.

Stage II. This stage is characterised by valvular action. As is well known bronchi dilate somewhat during inspiration and contract during expiration. It then follows that the stenosis becomes more marked during expiration than inspiration wherefore also the air passes the constricted bronchus more easily during inspiration than expiration. The air within the lung area corresponding to the constricted bronchus will thus be retained within that area. This causes the alveoli to become more filled with air and more expanded than normal. This retention of air will cause increase of the intra-alveolar pressure which in its turn will act upon the capillaries rendering them bloodless (LAURELL). This state of emphysema with consequent anaemia will appear in the radiogram as a definitely clearer area corresponding to the constricted bronchus. This greater translucency will become more marked during expiration than inspiration and for reasons already stated it will be wedge-shaped. As a result of expansion due to the increased intra-alveolar pressure the wedgeshaped area will present convex boundaries. In all-

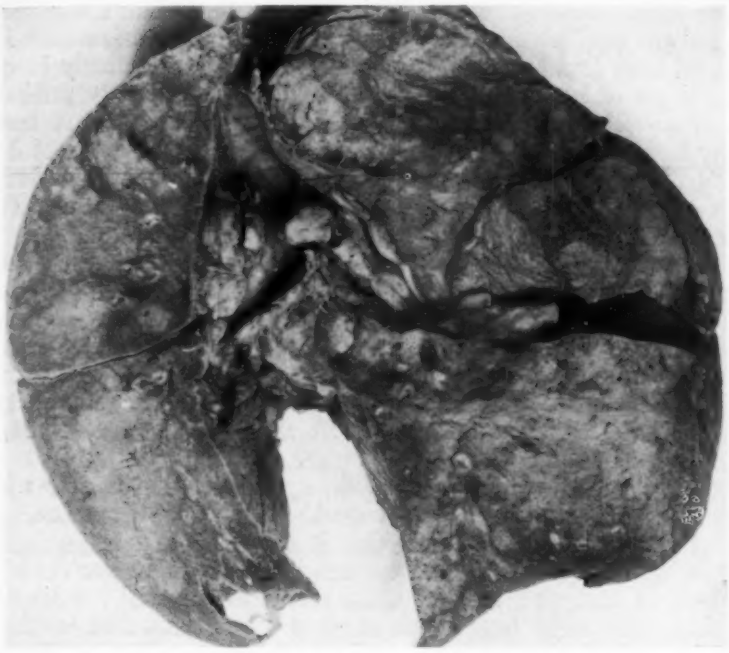


Fig. 7. Patho-anatomical specimen from a case where a metastatic tumour is seen to invade the right main bronchus and almost completely fill up its lumen, leaving but a slit-shaped air-space. The tumour seems to extend to the bifurcation and occludes in part the left main bronchus. Yet some passage was clearly to be seen. The right lung shows pronounced emphysema with considerable expansion of all the lobes. Microscopy showed alveoli to be markedly expanded. Anaemia in parenchyma obvious.

Left lung shows distinct though incomplete atelectasis. Air could be expressed from the finer bronchi and parenchyma. Lung moderately collapsed. Microscopy showed moderate collapse of alveoli and slight hyperaemia.

vanced cases of emphysema the wedge-shaped region may assume a more oblong or rounded shape, and if the expansion be well marked it may cause compression of adjacent lung tissue. This will cause a compression atelectasis in the surroundings of the emphysema which atelectasis may be more marked in some places than others and as a consequence band-shaped or circular atelectatic zones will form in the surroundings of the emphysema. As a rule however this atelectatic marginal zone is broader in the inner than the outer parts since the latter can more readily be displaced from the emphysematous area.

The most advanced forms of this emphysema assume the appearance of a bullous emphysema. All cases of bullous emphysema that I have seen and have had the opportunity of studying more closely have presented signs of bronchostenosis. JÄDERHOLM has recently published a case of so-called bullous emphysema where he opined that bronchography had revealed normal bronchi. A closer examination of JÄDERHOLM's pictures will however show that the finer bronchial branches in his case are occluded within the emphysematous area. By the increased volume of the lung brought about by the emphysema heart and mediastinum get displaced to the healthy side. This displacement is more marked during expiration than inspiration, hence the respiratory oscillation of heart and mediastinum. For a similar reason the diaphragm will become depressed and also make less respiratory movements than normal. The emphysema will also cause the thoracic wall to expand over the distributive area of the constricted bronchus. Fig. 8, 12, 13, 14, 15, 21, 22, 23, 24, 25, 26, 26 a, 27, 28, 28 a, 29, 29 a, 30, 31, 31 a, 33 and 34 show instances of this stage.

Fig. 7 illustrates the pathological specimen from a case where a metastatic tumour is seen to invade the right main bronchus, almost completely occluding its lumen. One is only able to detect a slitshaped air-space in the bronchus. The tumour is seen to extend to the bifurcation and to compress the left main bronchus yet without causing its occlusion. The right lung shows marked emphysema with considerable expansion of all the lobes. On microscopical examination the alveoli were found greatly distended and well-marked anaemia was present in the parenchyma. The left lung shows mild atelectasis and is moderately collapsed. Microscopy reveals moderate collapse of alveoli besides mild hyperaemia. The left lung thus shows a condition corresponding to stage I and the right lung to stage II.

Between stage I and II there is a transitory stage with an inspiratory atelectasis and an expiratory emphysema.

Stage III. This stage of bronchostenosis is characterised by the obstructive atelectasis arisen since in the case of complete occlusion the lung area corresponding to the occluded bronchus is shut off from the atmospheric air. According to LICHTHEIM's striking investigations the alveolar air within the shut-off portion of the lung is absorbed via the blood-channels. This worker was able to show that after ligation of a bronchus atelectasis arose some time afterwards in the lung lying beyond the seat of ligation. If the vessels supplying the same part of the lung were concurrently ligated no atelectasis arose. More recent investigations by CORYLLOS and BIRNBAUM, LEE, RADWIN, TUCKER and PENDERGRASS, REINBERG and others have shown that atelectasis can be observed radiologically 4—6 hours after artificial occlusion of

a bronchus. If before occlusion the lung be filled with oxygen instead of air atelectasis occurs already after half an hour. The readily absorbable oxygen is absorbed more quickly than nitrogen. The gas is absorbed in the alveoli until equilibrium is established between the gaseous pressure in the blood and that of the alveoli.

JACOBÆUS and the author have in some cases observed obstructive atelectasis to arise after lipiodol injection into healthy bronchi even immediately after the injection. In these cases there can be no question of absorption but the air has probably been forced out of the alveoli by coughing or by contraction of the bronchi, the opaque medium then preventing re-entry of air. This mechanism may be possible in cases of acute obstructive atelectasis caused by mucous plugs, blood or such like.

On account of air absorption the alveoli collapse and thereby come to occupy a diminished volume. This collapse causes diminished pressure in the alveoli. The blood capillaries thus become engorged with blood and often enough there even arises a secondary oedema in the atelectatic region. Both the hyperaemia and the oedema are readily recognised on the post-mortem table in cases of obstructive atelectasis. In these cases the lung is red and full of fluid. On microscopy the vessels are found to be hyperaemic. The hyperaemia and oedema have also been observed and described by LICHTHEIM, REINBERG, KOPZIOVSKAJA and ZATKIN, CORYLLOS and BIRNBAUM, HANSSON and SJÖSTRAND besides others. The last-mentioned authors have also shown that the lung increases in weight in obstructive atelectasis.

In the radiogram the atelectatic region appears as a massive shadow caused in part by the diminished air contents and partly by the hyperaemia and oedema. The site of the shadow corresponds entirely with the distributive area of the constricted bronchus. It thus assumes the shape of a wedge which can be seen in a projection suitable for the bronchus concerned. Through collapse of the alveoli after air absorption the atelectatic lung area also obtains a diminished volume. This causes the bordering surfaces to become concave. By reduction of the volume the surrounding healthy lung tissue undergoes expansion and will consequently hold more air than before. The atelectasis will thus be surrounded by areas definitely more translucent. The diminished lung volume also produces displacement of heart and mediastinum towards the affected side. This displacement is more marked during inspiration than expiration which leads to respiratory oscillation of the heart and mediastinum. For the same reason the diaphragm becomes elevated and makes less movements during respiration than normal and the thoracic wall becomes retracted over a site corresponding to the atelectatic lung area. Fig. 9, 10, 11, 15 a, 18, 19, 21 a, 23, 25 a, 25 b, 28 b, 29, 29 a, 31 b and 31 c show instances of this stage.

General complications. Complications are exceedingly common in bronchostenosis, particularly in the later stages. In the first stage, on the other hand, they are more uncommon. In this stage, however, we get now and again more or less marked bronchopneumonic changes. In the second stage an advanced bullous emphysema may easily rupture and spontaneous pneumothorax may then arise. According to my experience bronchostenosis would seem an exceedingly common cause of spontaneous pneumothorax. All the cases of spontaneous pneumothorax, of tuberculous as well as non-tuberculous nature, of which I have had the opportunity of making a closer study, have thus presented signs of bronchostenosis. In the third stage with obstructive atelectasis more or less marked pneumonic changes are usually present. In these pneumonic changes we get some exudation in the collapsed alveoli whereby these may in part become expanded. The reduction in volume in the case of atelectasis may then become less marked. This complication is frequently of very serious nature and often leads to abscess formation.

Another very common complication of obstructive atelectasis is pleurisy. If an obstructive atelectasis is allowed to remain for long inflammatory changes arise in adjoining pleura. Such changes can readily be detected on thoracoscopy or at the autopsy. A greater or smaller amount of pleuritic effusion may also be present.

In cases of chronic obstructive atelectasis bronchiectasis will sooner or later generally arise. As to its mode of origin I shall return to this subject later.

Differential diagnosis. From the point of view of differential diagnosis one has in the first place to consider lung embolism, pneumonia and pleurisy. Infarcts also give rise to wedge-shaped massive shadows and shows a similar localisation and distribution as those of obstructive atelectasis since the vessels in the main have the same distribution as the bronchi. An infarct, however, does not cause any reduction in volume and its boundaries are not concave as in obstructive atelectasis. In pulmonary embolism not neading to infarction anaemia ensues on the distal side of the embolus (WESTERMARK). This area is also wedge-shaped and appears on the radiogram as a more translucent area and may easily be confused with the emphysema in bronchostenosis. However these translucent wedges in lung embolism never expand and assume a convex boundary as does the bullous emphysema.

Interlobar exudates may easily be confused with obstructive atelectasis. They often assume the shape of a wedge but generally have a convex outline whereby they can be differentiated from atelectasis. There are also other localised pleuritic areas that may be confused with atelectasis.

Ordinary croupous pneumonia generally causes infiltration of a whole or several lobes but may also affect part of one lobe alone and may then be readily confused with atelectasis. Yet it causes no shrinking phenomena. As already stated, however, pneumonia often occurs in connection with atelectasis. Such conditions have always the same distribution as obstructive atelectasis but do not present so well marked shrinking phenomena as pure obstructive atelectasis.

The occurrence and course of bronchostenosis in different kinds of lungdisease

Bronchostenosis may arise in one of the following ways:

A. By changes in the lumen which entirely or in part cause its stenosis. Such stenosis may be caused by secretion, mucus, pus, blood, foreign bodies etc.

B. By changes in the bronchial wall, causing stenosis of the lumen entirely or in part. Such wall changes may arise as a result of some inflammatory condition, such as acute or chronic bronchitis, bronchiectasis, tuberculosis, lues and so on, cicatrices, tumours.

C. By changes outside the bronchial wall compressing the lumen entirely or in part. Such compression may be caused by enlarged lymphnodes, new growths, aneurysm etc.

Bronchostenosis may be solitary or multiple. Solitary are generally those belonging to group A and C and those of group B caused by tumours before there have produced too marked an infiltration. Multiple are generally those stenosis caused by inflammatory changes in the bronchial wall. Such cases of inflammatory origin are often localised to bronchial branches of the third to sixth degree. In acute stages such stenoses are generally localised to one and the same side-bronchus, whereby the same picture is obtained as if this sidebronchus were occluded. In chronic stages the branches of different side-bronchi may be constricted whereby a multiple localisation of the changes is obtained. Any of the causes of bronchostenosis may produce its three different stages.

Group A. Bronchostenosis caused by changes in the lumen

To this group belong in the first place such cases where the stenosis is caused by plugs of mucus, pus or clots of blood, thus for instance emphysema or atelectasis arising in connection with acute bronchitis when a mucous plug may occlude the lumen. These changes are quite transient and run a very acute course. They often disappear on the pa-

tient sustaining some knock when the plug alters its position or on the patient assuming different positions when it may pass on. This group also includes post-operative pulmonary collapse, above all described in American literature. Here, too, it is a question of a mucous plug occluding the lumen thus causing atelectasis. According to SANTE these cases, too, generally run an acute course. Some cases, however, may run a more protracted course. As a rule, however, these cases are dealt with in a satisfactory manner by shifting the position of the patient or by bronchoscopic aspiration of the affected bronchus.

This group also includes cases of so-called haemoptysis atelectasis, earlier described by JACOBAEUS and the author 1929 and subsequently also observed by several other authors. According to our experience such atelectasis mainly occurs after relatively severe haemoptysis and in cases with a short history. Such cases, too, run a very acute course as the blood is removed from the bronchi by coughing or by shifting the patient's position.

Finally are referred to this group cases of bronchostenosis caused by foreign bodies. These cases, however, unless early diagnosed, seem to assume a chronic course with harmful influence on the lung parenchyma. As instances of such cases making up different manifestations and stages of bronchostenosis the following cases may be quoted.

Case 1. T. Ö. Fig. 8. A foreign body (drawing-pin) is seen located in the bronchus hyparterialis dx. There is emphysema of both the lower lobes with anaemia. There is thus much expansion of these lobes, the upper border being displaced considerably upwards. The limiting surface is convex. The vascular design in these lobes is less marked than normal. The upper lobe is somewhat compressed and shows diminished aeration, above all in its lower parts. A moderately distinct bandshaped shadow with an upper convex surface is marking the boundary between the lobes.

Case of valvular stenosis of bronchus hyparterialis dx. caused by an opaque foreign body.

Case 2. M. B. Fig. 9. This case illustrates an obstructive atelectasis of the lower branches of bronchus hyparterialis dx. Radiography shows a wedge-shaped massive shadow with concave outlines within the basal posterior portion of the lower lobe. In the apex of this wedge-shaped shadow there is seen a rounded attenuation, the size of about a bean. The patient then coughed up a sallow flower after which the atelectasis completely disappeared. The sallow flower seems to have brought about the attenuation mentioned above and produced the obstructive atelectasis on its distal side.

Case of obstructive atelectasis caused by a non-opaque foreign body.

Case 3. I. A. Fig. 10. In this case there is a massive shadow including both the lower lobes. These are markedly collapsed with their upper bounding surface depressed. This surface is concave. The upper lobe is much expanded and emphysematous. At the apex of the massive shadow there are two somewhat elongated dense shadows. These proved to consist of bones from a piece of cutlet. These bone fragments had pro-

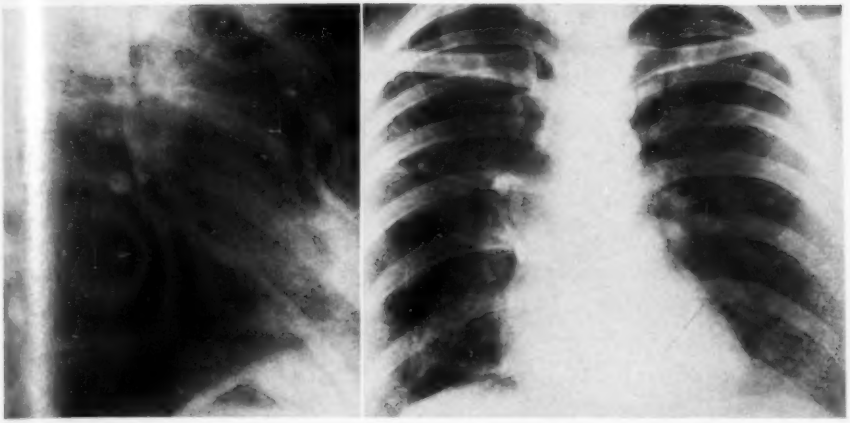


Fig. 8. Case 1. A foreign body, a drawing pin, is seen located in bronchus hyparterialis dx. Lower and middle lobes much expanded pushing upper lobe upwards and presenting an upper convex bordering surface. Lobes clearly emphysematous and anaemic.

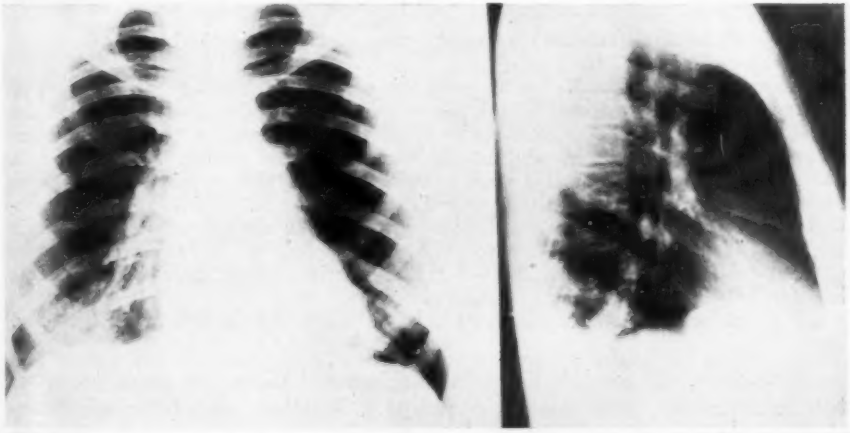


Fig. 9. Case 2. A foreign body, a sallow flower, located in the lower part of bronchus hyparterialis dx. The basal and posterior part of the lower lobe is seen to include a massive wedge-shaped shadow with concave bounding surfaces. In the apex of the wedge there is a thinner area, the size of about a nut, probably representing a foreign body.

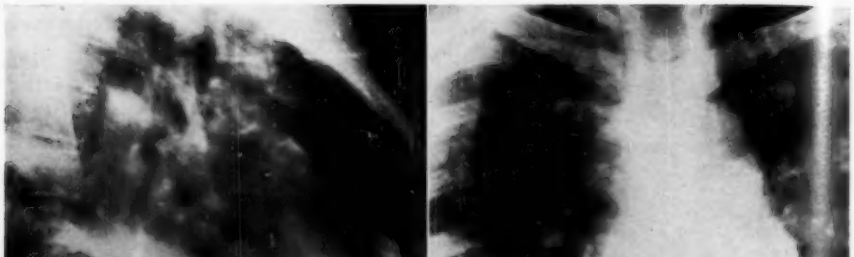


Fig. 10. Case 3. Case of foreign bodies (bone fragments) located in bronchus hyparterialis dx. Fairly elongated dense shadows can be seen in the bronchus. Lower and middle lobes are massively opacified with concave bounding surfaces (obstructive atelectasis).

duced complete occlusion of the bronchus hyparterialis with consequent obstructive atelectasis of the two lower lobes.

Case of obstructive atelectasis caused by an opaque foreign body.

Case 4. G. H. Fig. 11. For 35 years this case has been under treatment for pulmonary tuberculosis, yet bacilli were never found. On radiological examination one found considerable shrinking of the entire left half of thorax with displacement of heart and mediastinum to the left. On films of good penetration and on lateral pictures a nail was found located in the left main bronchus. On the patient being told of this he remembered having »swallowed» 35 years earlier a small nail. Besides the above mentioned shrinkage and opacity hard films revealed well marked ectatic areas within the whole lung. In this case, therefore, the patient seems to have aspirated, 35 years earlier, a nail which subsequently gave rise to massive obstructive atelectasis of the left lung with secondary ectatic formations.

Case of obstructive atelectasis with ectasis caused by an opaque foreign body.

Comments. A foreign body in the bronchi does not seem to occur too infrequently, particularly in children. In the case of chronic bronchostenosis one should always bear that possibility in mind. Foreign bodies of metallic or bony nature would generally seem to be readily recognised on direct pictures while foreign bodies giving no visible shadows may easily be missed. In the case therefore of chronic bronchostenosis one should have a foreign body in mind and carry out, first a bronchographic examination and then bronchoscopy. By the bronch-

graphic examination the foreign body generally gets covered with the opaque medium and is consequently easily recognised.

It is exceedingly common for foreign bodies, at any rate in an acute case, to get shifted from one bronchus to another. This has been pointed out above all by MAYGES. It is advisable therefore always to carry out a roentgen examination immediately prior to bronchoscopy for the sake of localising the body. In so doing one should remember that the foreign body may have produced inflammatory changes at its former site. These inflammatory changes may in their turn have produced a persistant stenosis. In such cases we may thus have a multiple formation of bronchostenosis.

Fig. 11. Case 4. Case of foreign body (small nail) in situ in the lung for 35 years. It seems to be lying in the left main bronchus. The whole lung massively opacified. With good penetration however well marked streak-shaped cavitations (bronchiectasis) appear on film.

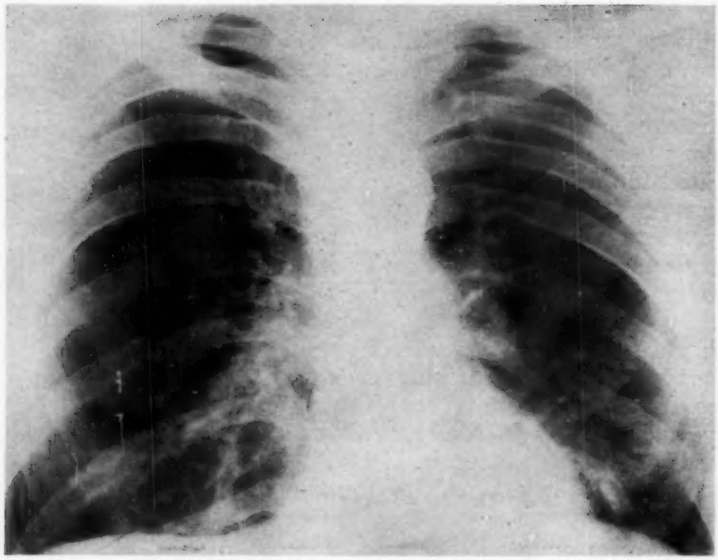
Group B. Bronchostenosis caused by changes in the bronchial wall.

1. Non-specific inflammatory changes in bronchitis and bronchiectasis.

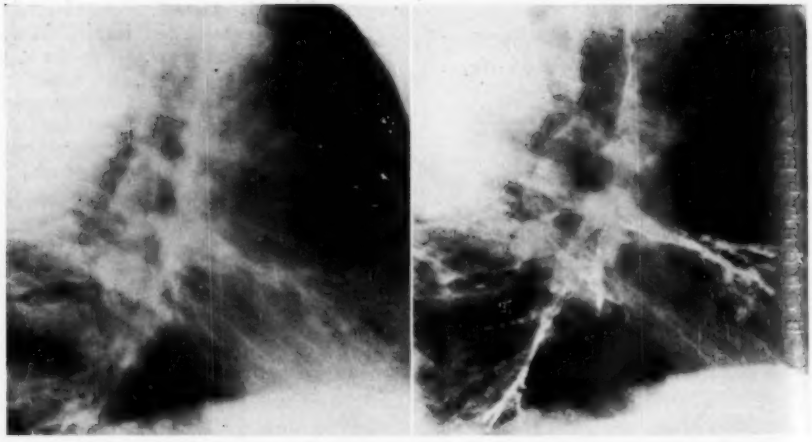
Case 5. K. S. Fig. 12. In this case we find a rounded wedge-shaped more translucent area within the anterior basal portion of the lower lobe. This area is surrounded by a fairly broad dense marginal zone and is more apparent on a lateral picture since in the anteroposterior projection it is covered by the partly infiltrated middle lobe. After bronchography the second ventral branch of bronchus hyparterialis was found the seat of stenosis. The bronchus ends up by a rounded convex outline. In the rest of the bronchus there is no visible infiltration.

Here is a case then of solitary stenosis of inflammatory origin of the second ventral branch of bronchus hyparterialis dx. with secondary emphysema and anaemia of the corresponding lung area. Surrounding lung tissue is atelectatic.

Case 6. G. S. Fig. 13. In the basal and posterior part of the lower lobe we here find a lighter area of rounded shape; in the antero-posterior picture it covers almost completely a pleural shadow in the posterior lower part of the thorax. This pleural shadow is well apparent in the lateral picture. This case is thus a beautiful illustration of the way a bullous emphysema may hide a fairly large pleural effusion.



a.



b. c.

Fig. 12. Case 5. Case of bronchostenosis in chronic bronchitis. The anterior lower part of the lower lobe, corresponding to the distributive area of the second ventral branch of bronchus hyparterialis dx., is the seat of obvious emphysema. This emphysema shows a convex outline and is surrounded by a dense marginal zone. On bronchography the second ventral branch of bronchus hyparterialis is found to be occluded a few centimetres from its origin. The stenosis presents a smoothly rounded outline.

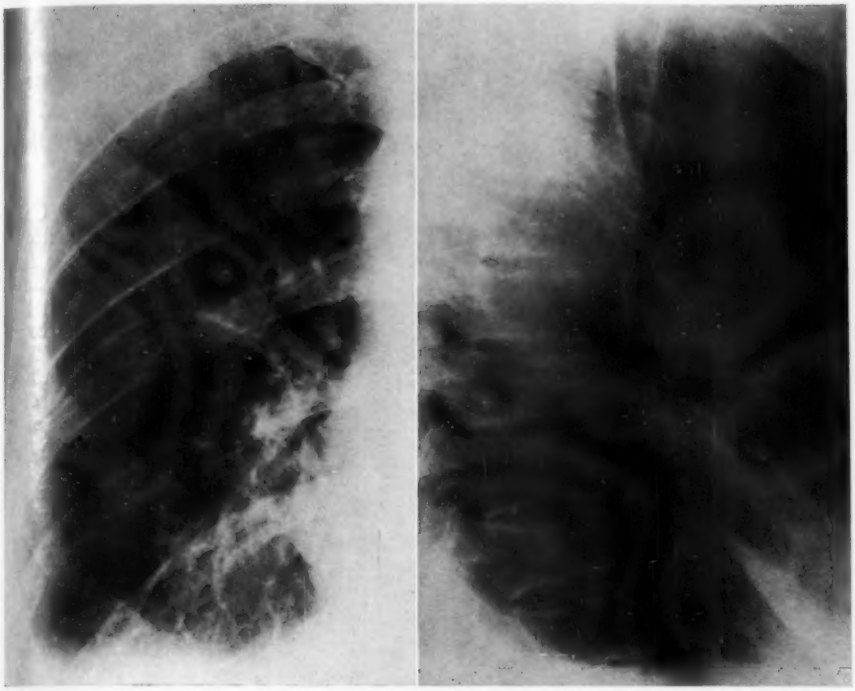


Fig. 13. Case 6. The posterior basal part of the right lower lobe is the seat of an emphysematous area with a convex outline. This area is bounded by a dense marginal zone. In the anterior lower part of the same lobe there is a smaller wedge-shaped shadow.

Case 7. G. S. Fig. 14, 14 a. These pictures show a considerable emphysema of the posterior basal parts of the lower lobe. The upper lobe and possibly part of the anterior portion of the lower lobe are seen to be greatly collapsed in a direction medially-upwards. There is no lung structure to be noticed within the emphysematous region. One suspected at first a shut-off pneumothorax but on thorascopic examination the condition instead proved to be a greatly emphysematous lung. Pneumothorax was subsequently induced in this case and bronchographic examination revealed multiple constrictions of the bronchi of the lower lobe.

Case 8. J. B. Fig. 15, 15 a, 15 b. At the first examination there was considerable emphysema of the entire lower lobe and parts of the upper lobe. A fortnight later the patient was taken ill with pyrexia. Examination then showed massive opacity of the lower lobe. From having been displaced to the right side the heart now proved to be displaced to the left. On the first occasion there was thus a bullous emphysema of the lower lobe. In connection with the feverish condition complete occlusion of the bron-

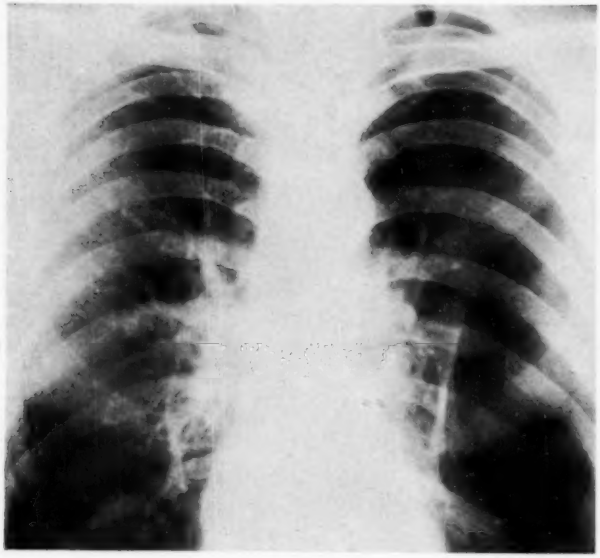


Fig. 14. Case 7. Case of well marked bullous emphysema in the left lung. The emphysema comprises most of the lower lobe and parts of the upper lobe. The anterior lower part of the upper lobe is displaced towards the side and compressed by the expanded lung. No vascular design can be detected in the emphysematous area.

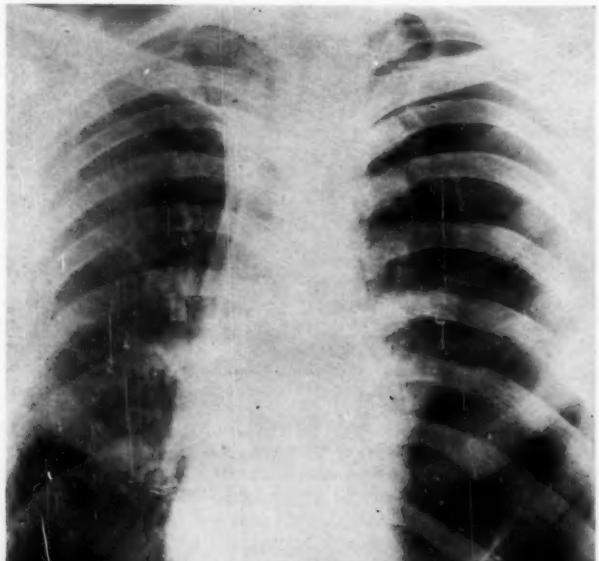


Fig. 14 a. The same case one week later when spontaneous pneumothorax had arisen. The emphysematous parts of the lung are seen expanded with a rounded outline in the pneumothorax cavity. No vascular design can be seen here. On bronchography the bronchial branches were later seen to be occluded.

Fig. 15. Case 8. Well marked bronchiectasis in left lung. The lower lobe is seen the seat of well marked bullous emphysema.

Fig. 15 a. Same case a fortnight later. Lower lobe is now seen to be massively opacified and heart and mediastinum are clearly displaced to the affected side.

chus had taken place with secondary obstructive atelectasis within the lower lobe. Bronchographic examination revealed extensive saccular ectasies with stenosis of the bronchial branches. During the stage of atelectasis the ectasies increased considerably in size.

Fig. 15 b. Same case after bronchography showing considerable saccular dilatations.

Comments. A bronchostenosis caused by inflammatory changes of the bronchi of non-tuberculous nature, as exemplified by the above cases, I regard as a typical pulmonary disease usually running a chronic course. In my experience the condition is fairly common. It often starts in connection with pneumonia or a severe bronchitis. Inflammatory changes then arise in one or several bronchial branches generally from one and the same lateral bronchus. Through oedema and infiltration such inflammatory changes produce, generally in their acute stage, complete occlusion. Obstructive atelectasis then arises within that or those parts of the lung located on the peripheral side of the single or multiple stenosis. On recovery from this acute stage the oedema and inflammation subside whereby the occlusion clears up. Should however the process fail to clear up completely a valvular stenosis may arise with secondary emphysema of those pulmonary areas corresponding to one

Fig. 16. Lipiodol injection post mortem. Lower lobe massively opacified. Side branches of bronchus hyparterialis occluded. Heart and mediastinum displaced to the affected side.

or several constricted bronchi. On renewed infection occlusion again arises with secondary obstructive atelectasis.

JACOBÆUS and the author have earlier shown how obstructive atelectasis, particularly when large areas of the lung are involved, leads to diminished pressure in the thoracic cavity. The pressure are thus diminished outside the bronchi. On the other hand there is a stagnation of bronchial secretion on the peripheral side of the stenosis. In the case of lively secretion there is an increased pressure in the bronchial lumen itself. There is thus a reduced pressure outside the bronchus and an increased pressure within. This difference in pressure may be rather considerable and will then tend to dilate the bronchial wall, particularly in cases where the tonus of the wall has become impaired as a

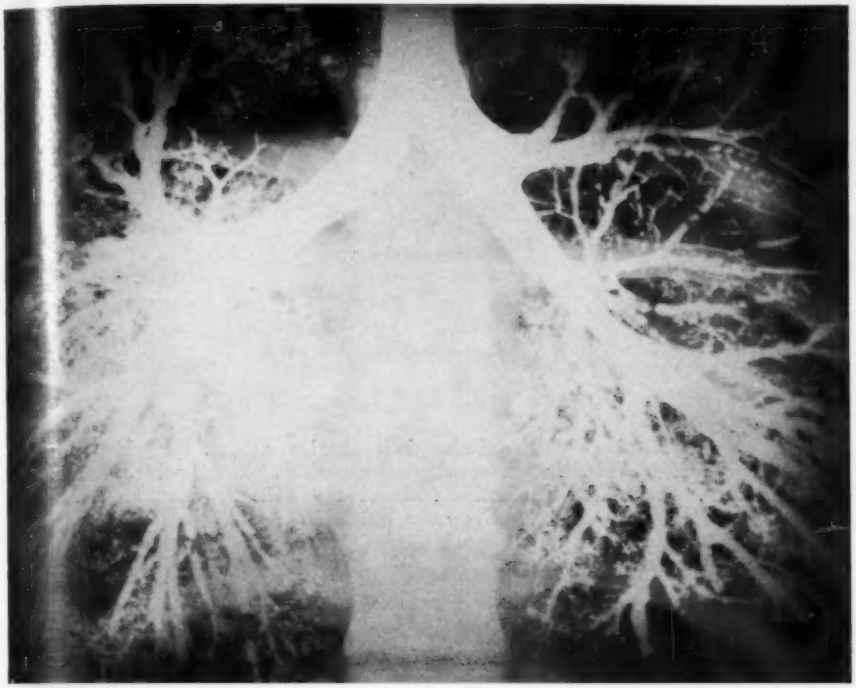


Fig. 17. Lipiodol injection post mortem. In the posterior upper part of the lower lobe and in the posterior part of the upper lobe there is a massive opacity. The bronchial tree is well filled. Only the finer bronchi are seen partly occluded within the opacified area. No displacement of heart and mediastinum.

result of previous inflammatory changes. This would seem a very frequent cause of bronchiectasis.

JACOBÆUS and the author have earlier published a number of cases where bronchiectasis was present and rapidly grew worse during a stage of atelectasis. I have also later come across many cases of that nature. This difference in pressure as a cause of bronchiectasis seems to me more probably than the generally accepted view of fibrous shrinking. Although such fibrous shrinking should really be expected to produce an irregular lumen of the bronchial dilatations, the fact is that these have generally a rounded lumen, the saccular as well as the cylindrical forms.

This progressive stenosis of inflammatory origin often runs a course with acute intermediary stages accompanied by secondary obstructive atelectasis. During these stages of atelectasis the ectasies are in the

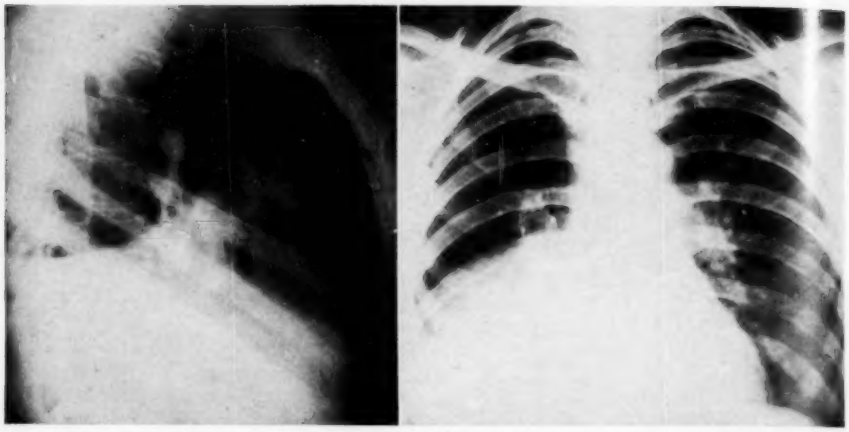


Fig. 18. Case 9. Massive opacity within middle and lower lobes, excepting the upper posterior parts of the latter. The opacity has a concave bounding line upwards and forwards. Heart and mediastinum displaced towards the affected side. Obstructive lobar pneumonia.

habit of showing more or less rapid aggravation. After these acute intervals we then get more or less prolonged periods of valvular stenosis accompanied by a more or less marked bullous emphysema. During these periods there is relative recovery until the next acute exacerbation takes place.

The final stage of this progressive bronchostenosis is thus a condition of well-marked bronchiectasis.

For a reliable diagnosis bronchography is essential. These inflammatory stenoses appear with an evenly rounded outline. They are multiple and localised to the bronchial branches of one and the same lateral bronchus. In more advanced cases several lateral bronchi may be affected. The opaque medium never reaches the finer bronchial branches on account of the stenosis present. In the presence of ectasies these appear, all according to their type, as diffusely dilated bronchi or as saccular dilatations.

2. *Non-specific and inflammatory changes in connection with pneumonia.*

So far my experience goes pneumonic cases may be classified, from a radiological point of view, into two different types, pneumonia combined with a more or less marked atelectasis, so-called obstructive pneumonia, and genuine pneumonia characterised by inflammatory changes in the lung parenchyma.

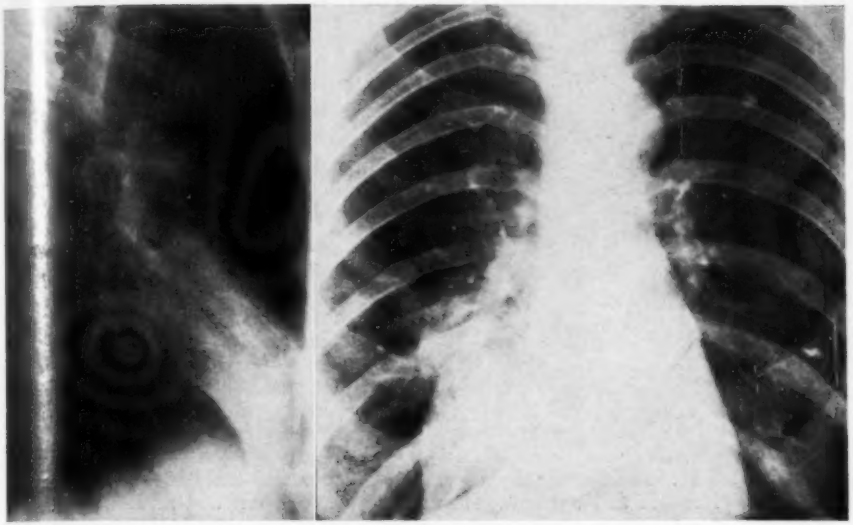


Fig. 19. Case 10. Massive opacity in the anterior medial portion of the right middle lobe with a concave limiting contour laterally and backwards.

For a closer study of this question I made a special examination of 16 cases of acute pneumonia who had all ended fatally. Immediately after death or after two hours at most I injected lipiodol into the trachea and filled up the whole bronchial tree. Radiograms were then taken in different directions. The radiograms were then compared with the lungs cut into horisontal sections serial and afterwards immediately fixed. Microscopical examination was also carried out. The technique followed for the purpose of this lipiodol injection and the comparative study carried out were the same as earlier described in my investigation of the bronchi in pulmonary tuberculosis.

In these post-mortem examinations I found in 3 cases occlusion of the bigger bronchi of the first or second degree (Fig. 16). In the rest of the cases I found but occlusion of the finer bronchi of the fifth or sixth degree or else there was no occlusion of the bronchi at all (Fig. 17).

Those cases having the bigger bronchi occluded all showed distinct displacement of heart and mediastinum towards the affected side. The occlusion proved to be caused by fibrinous and purulent exudate infiltrating the bronchial wall and the bronchial lumen. In the lung parenchyma obvious collapse of the alveoli was in evidence besides effusion in them.

Fig. 20. Case 11. Massive opacity of the right lower and middle lobes with convex outline forwards and upwards. No displacement of heart and mediastinum. Genuine lobar pneumonia.

In those cases where occlusion could only be observed in the finer bronchi or where there was no occlusion at all, there was no displacement of heart and mediastinum either. The alveoli were filled with secretion and not collapsed.

The outcome of these observations is that a distinction can be made between on the one hand, pneumonia with occlusion of the bigger bronchi where the pneumonic changes were combined with obstructive atelectasis of the lung tissue and the bronchial occlusion was probably the primary factor and, on the other hand, pneumonia without any occlusion of the bronchi or with occlusion of but the finer branches where the pneumonic changes were entirely unconnected with any alveolar collapse whatsoever. By these comparative investigations, radiological and patho-anatomical, I was thus able to verify my observations of the 2 different types of pneumonia, obstructive pneumonia and genuine pneumonia.

As illustrations of these different types of pneumonia the following cases may be quoted.

Case 9. S. H. Fig. 18 and 18 a. Acute onset with rigors and fever; pneumonia diagnosed clinically. There were dulness and weakened breathsounds over the base of the right lung. On radiological examination there was found massive opacity including the midlobe and the lower lobe but for its upper posterior portion. Thi

massive opacity presents upwards as well as forwards a concave outline. Heart and mediastinum are displaced to the right side.

The midlobe and the lower lobe excepting its upper posterior portion are thus the seat of obstructive atelectasis presenting obvious signs of aspiration phenomena.

Complete resorption had taken place after 10 days.

Case 10. K. S. Fig. 19. Taken acutely ill with sharp pains, rigors and fever. On clinical examination nothing pathological was found. Roentgen examination revealed a massive wedge-shaped shadow within the anterior medial portion of the right middle lobe. The shadow shows a concave outline downwards and laterally. The process had cleared up completely after a fortnight.

It is thus a case of obstructive atelectasis of the anterior medial portion of the middle lobe, combined with pneumonia.

Case 11. E. R. Fig. 20. Taken acutely ill with sharp pains, rigors and fever. On clinical examination there was dulness over the back of the right lung and wheezing bronchial breathing. Roentgen examination showed a massive shadow of the midlobe and lower lobe on the right side. Upwards and forwards the massive shadow has a convex outline. There is no displacement of heart or mediastinum. Recovery was established after 11 days and the changes had then almost completely cleared up. This is a case therefore of true pneumonia affecting the lower and middle lobes on the right side.

Comments. Obstructive pneumonia is characterised radiologically by a larger or smaller wedge-shaped massive opacity with concave bounding surfaces. This opacity engages a larger or smaller part of a lobe (see case 10) and corresponds to the distributive areas of one or more adjacent bronchial branches. In some cases the opacity may occupy an entire lobe or several lobes (see case 9). The bounding outlines of the lobes are then generally concave and the lobes occupy a smaller volume than normal. Heart and mediastinum are displaced to the affected side, the thoracic wall is retracted and the diaphragm elevated.

Genuine pneumonia (see case 11) is characterised by one or several lobes being massively opacified. The outlines of the lobes are generally more or less convex and the lobes occupy often a larger volume than normal. One is generally able to distinguish the air-carrying bronchi within the shadow. No signs of displacement.

These two different types of pneumonia also differ from a clinical point of view. Thus obstructive pneumonia does not usually exhibit the same sudden onset with rigors and high temperature as genuine pneumonia. The former also shows a milder course than the latter.

The two pneumonic forms also seem to differ in regard to possible complications. If in obstructive pneumonia the bronchial occlusion does not subside through absorption but persists for some time, liquefaction of the parenchyma supervenes within the occluded lung region as in other chronic bronchial occlusions with the result of a lung abscess. According to my experience lung abscess is quite a common complica-

tion in obstructive pneumonia while it occurs relatively seldom in connection with genuine pneumonia. Pleural empyema, on the other hand, seems to be a more frequent complication in genuine pneumonia than in obstructive pneumonia.

There would seem to be sufficient reasons therefore to distinguish between obstructive and genuine pneumonia, not only from a roentgenological but also from patho-anatomical and clinical points of view.

(To be continued in next number.)